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UNITED STATES DEPARTMENT OF AGRICULTURE
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RESULTS OF CODLING MOTH INVESTIGATIONS, 1945

Part I

Work Conducted by State Agencies,
Entomological Branch, Canadian Department of
Agriculture and Commonwealth of Australia
and
Commercial Entomologists

Not for Publication

This pool of information on the results of codling moth research for the season of 1945 is the thirteenth of a series of similar summaries prepared annually by the Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, at the request of the Committee on the Codling Moth of the American Association of Economic Entomologists. These data are assembled for the confidential information of workers who are interested in the codling moth problem. The material is not for publication and is therefore not available for quotation or other use without specific permission from the agency which has furnished it.

ARKANSAS

Dwight Isely, Arkansas Agricultural Experiment Station, Fayetteville.

REPORT OF CODLING MOTH IN ARKANSAS FOR 1945

The codling moth was of relatively little importance, in Arkansas in 1945, since most of the apple crop was destroyed by a frost in April after apples were in bloom. The weather during the period of emergence of overwintering moths from late April to early June was relatively unfavorable to the moths. Partly for this reason in the few orchards where enough of the crop escaped injury to justify a full spraying program, the codling moth was fairly well controlled.

A limited experiment was conducted by the Department of Entomology to compare DDT with arsenate of lead in codling moth control. The orchard chosen was one in which the crop as a whole was considered by the operator as too light to justify spraying. It was selected for the reason that if the fruit sprayed with DDT was not salable it would not be considered a loss. Also there were enough trees of a single variety, Golden Delicious, with a fair crop to be suitable for a spraying experiment. Nothwithstanding the fact that the season was relatively unfavorable to the codling moth, this orchard presented a severe test. It had been heavily infested in 1944. Most of the orchard was unsprayed in 1945 and therefore served as a reservoir of continuous reinfestation for the sprayed plots. In the sprayed plots effective control operations did not really start until the beginning of the second generation which was after a fairly heavy infestation had already developed.

The spraying experiment involved only two plots. One was sprayed with arsenate of lead at the rate of 3 pounds in 100 gallons of spray mixture. The other was sprayed with water miscible DDT at the rate of 1 pound of actual DDT to 100 gallons. An accellerated schedule was applied making 5 applications for the second generation and the early part of the third. The first application was made on June 25 and the last on August 13. Harvest was September 25. The infestation of harvested fruit was as follows:

DDT plot	1.87% wormy
Arsenate of lead plot....	32.20% wormy
Unsprayed plot	77.31% wormy

The control by DDT was remarkable since it stopped an infestation after it was already under way. Furthermore it protected the fruit during the long interval between the last application and harvest. The records for the unsprayed check do not fully indicate the severity of the infestation since much of the fruit dropped before harvest.

A light red spider infestation appeared on the DDT plot near the end of the season.

CALIFORNIA

G. E. Carman and C. A. Fleschner, California Agricultural Experiment Station, Riverside.

III. CONTROL EXPERIMENTS

Experimental and semi-commercial field tests were made on Bartlett pears and Rome Beauty apples to determine the importance of various factors in the use of DDT preparations and to observe the value of DDT spray programs when applied by growers to relatively large orchard areas.

In previous work with DDT, spray suspensions of solids had been most satisfactory for codling moth sprays on apples and pears. While preparations of this type containing only less than 50 percent DDT were available in quantity at the time these studies were initiated, it was considered expedient for other reasons to standardize on 50 percent concentrates which were, in addition, water dispersible without the inclusion or addition of surface active supplements. Accordingly, several extending materials were selected for use in these studies on the sole basis that in composition with 50 percent DDT the resulting mixtures were satisfactorily wettable so as to obviate the need for supplemental wetting or dispersing agents.

The spray concentrates for the field tests were processed in a Bantam Mikro Pulverizer hammer mill. The DDT and extender were premixed before milling and each concentrate was milled a minimum of three times.

In field practice the spray concentrates were added directly to the tank without previous slurrying. Fungicides were not required in any of the spray schedules but in some cases materials for mite control were combined with the DDT concentrates.

The timing of spray applications was patterned after the schedules developed in each area for the standard lead arsenate sprays with necessary allowances for seasonal variations, as indicated by bait collections and periodic field observations in each district.

In all cases codling moth results were based on an examination of all drop fruits and of a sample of 400 harvested fruits and on a count of the remaining harvested fruits.

Since injury to pear leaves caused by the Pacific mite, Tetranychus pacificus McG., results in a drying up and dropping of the leaves, mite injury was estimated by counting the number of leaves falling into uniformly delineated areas under each tree.

All fruit and leaf samples for analytical determinations of DDT deposits or residues were assembled in duplicate or triplicate from predetermined stations in each replicate with a random selection at each station. All DDT analyses reported herein were made by Mr. F. A. Gunther of this Station and his assistants, using the dehydrohalogenation method.

A. Bartlett Pears, Antelope Valley

1. Primer Ranch, Little Rock. The spray treatments, dates of applications and results are summarized in Table 1.

The comparison of three dosage levels indicated that the use of 3/4 pound of actual DDT (treatment 2) gave significantly better control than the 1/2 pound dosage (treatment 3), whereas there was little added advantage in using one pound of actual DDT (treatment 1). The fact that much better control was obtained with the 1/2 pound dosage of DDT in the semi-commercial tests on pears (Tables 2 and 3) than in the experimental plots is noteworthy. While several differences in the constitution and handling of the plots existed which are incapable of evaluation, it is suggested that the comparison of trees receiving an effective mass treatment with similarly treated single tree replicates bordered by less effectively treated trees which maintain or increase population levels may account for a large part of the observed difference on the basis of percentage survivals reflected in actual numbers when the number of entry attempts varies greatly.

Treatments 3-7 in Table 1 had the same dosages of DDT. While the oil-DDT (treatment 4) and the sulfur-DDT fusion (treatment 7) programs gave better codling moth control, the former was not effective against the Pacific mite and the fusion mixture caused severe injury to fruits and leaves. Only 1/4 pound of DDT combined with 2 pounds of xanthone (treatment 8) gave poorer codling moth control than the 1/2 pound dosage of DDT (treatment 3), but mite control was promising. Very slight amounts of fruit injury were found on trees sprayed with DN-111 or DN-211 (treatments 5 and 6 respectively).

The higher dosages of DDT appeared to give slightly better control of the Pacific mite. In 1944 tests, 2 pounds of actual DDT gave better control of the mite than lead arsenate-oil schedules. Trees sprayed with Ryanex (treatment 9) were practically defoliated by harvest because of mite injury.

While the addition of dinitro compounds and a spreader to DDT spray concentrates appeared to lower the deposits of DDT on leaves and fruits, there was no corresponding reduction in codling moth control. No wash tests were made on pears but the magnitude of the DDT residues at harvest suggests that no appreciable difficulty will be encountered in bringing fruits sprayed with the lower dosages of DDT under the provisional tolerance for DDT residues on pears.

2. Carr Ranch, Little Rock. The experimental set-up and results of the semi-commercial field test are given in Table 2.

Unseasonable weather during the bloom of pears in this area so consistently prolongs the bloom period that growers have usually found it necessary to apply two calyx sprays of lead arsenate in order to protect all calyces. However, since the over-all effectiveness of DDT sprays and the manner in which DDT appears to differ from lead arsenate in its mode of toxic action suggested the possibility of eliminating one or possibly both calyx sprays, an effort to evaluate such programs was undertaken. Codling moth larvae were found in pears before May 9 in this test orchard this year while quite generally eggs can be found around the time of the first calyx spray or shortly thereafter every year. But because of the difficulties encountered in this area in making these early applications, particularly because of high winds which restrict growers to night spraying, it was felt that some worminess from early first brood larvae could be tolerated if satisfactory control of late brood larvae with DDT was realized.

The results of the test indicate poorer control whenever any of the calyx sprays are deleted but the differences in control between the DDT schedule without either calyx spray and the grower's standard lead arsenate schedule appears to have particular significance for the growers because of the difficulties they have in completing these earliest applications.

Wettable sulfur applied in the first cover spray for Pacific mite control in this block was effective in keeping down populations until shortly after harvest. The sulfur applied at this time caused some injury to pears on the southern periphery of the trees.

This orchard was severely damaged by pear blight this year and independent observations made by the grower and by the investigators concurred in the opinion that there was significantly less blight in the DDT treated areas than in the lead arsenate sprayed areas.

3. Bones Ranch, Little Rock. This semi-commercial field test which is summarized in Table 3 was set up to determine the value of DDT applications for codling moth control and of the three materials selected for trial with DDT, DN-111 (treatment 3) applied at the rate of 3/4 pound per 100 gallons in the first cover spray was the only one which gave promising control. A very slight and insignificant amount of fruit injury was caused by the DN-111 spray and its use under some conditions might result in considerable fruit injury. A single application of xanthone was ineffective whereas its use in all the cover sprays (Table 1) gave promising mite control.

The clover mite, Bryobia praetiosa Koch., did not develop in numbers on any of the pear test plots this season although present in each orchard.

B. Rome Beauty Apples, Rivers Ranch, Oak Glen

1. Composition of DDT spray concentrates. The experimental set-up and results are summarized in Table 4.

In order to compare the several grades and/or compositions of DDT used in this test the composition or dosage of all treatments (except treatments 10 and 11) was adjusted so as to give 1/2 pound of actual para para prime isomer (DDT) per 100 gallons. In these treatments the amount of solids per 100 gallons was the same except in treatments 4 and 5 where the effects of varying the ratio of DDT to extender were being studied.

The milling procedure adopted for the various DDT spray concentrates was modified in the case of treatment 6 to determine if more millings would materially increase the effectiveness of a concentrate. Treatments 3, 7, 8, and 9 were tested to determine the effect of several extending materials when used in the preparation of DDT spray concentrates.

The codling moth results indicate that the variables under test were not limiting in the selection of DDT spray concentrates prepared and used in the manner indicated.

All treatments within this test received DDT sprays of approximately the same dosage as used in the semi-commercial test on apples (Table 6) and gave comparable codling moth control which is in contrast to the results of the pear tests and in support of the suggested explanation.

The magnitude of DDT surface residues on fruits at harvest compares favorably with the value (1.7 p.p.m.) obtained for the same dosage level in the 1944 tests on apple samples taken on October 26.

2. The use of supplements with DDT and the evaluation of other organic insecticides. The summarized results of this field test are given in Table 5.

The dosages of the DDT sprays were adjusted to give 1/2 pound of actual para para prime isomer (DDT) per 100 gallons of spray. None of the supplements used with the DDT spray concentrate significantly improved the efficiency of the concentrate when used without supplementation (treatment 1). DDT dissolved in Velsicol AR 60 (treatment 6) gave comparable control to the spray suspensions of solids and did not cause any apparent injury to the trees. However, this composition did not appear to offer any distinct advantages over the wettable spray concentrates and conceivably could be detrimental to the health of operators using it more or less continuously.

The spray composition of dichloro diphenyl dichloroethane or DDD (treatment 8) was unsatisfactory to handle in the spray tank, presumably because of the wetting agent used in the mixture. For this reason the results probably do not indicate the relative efficiency of this compound in the control of codling moth.

The sample of benzene hexachloride used in this preliminary test (treatment 10) contained only 10-12 percent of the insecticidally active gamma isomer and on the basis of this test it is not concluded that this insecticide material is ineffective against codling moth.

The omission of the calyx spray on apples did not result in a significant increase in worminess. In this area it would be feasible to omit the calyx spray on apples in DDT spray programs if powdery mildew was being satisfactorily held in check.

3. Semi-commercial field test. The results of this field experiment are summarized in Table 6.

The applications were timed and applied by the grower in the regular manner so as to indicate the results that might be expected if growers undertook to use DDT in their regular spray programs. The 15-1/2 acre block of large Rome Beauty apple trees used in the test was divided so that 10-1/2 acres on one side were sprayed with DDT and the remainder of the block with lead arsenate. Codling moth control appeared to be uniformly good throughout the DDT sprayed block except in the two rows adjacent to the lead arsenate sprayed trees.

In all the apple tests whenever trees were sprayed with DDT there was a serious build-up of clover mites, Bryobia praetiosa Koch., and an appreciable increase in woolly apple aphid, Eriosoma lanigera (Hausm.), colonies. While this was also true of treatments, 7, 8, and 9 (Table 5), it may have been because of their close association with DDT sprayed trees since it is believed that DDT is instrumental in upsetting the parasite and/or predator control complex.

A spray of DN-111 (3/4-100) during August gave good control of the clover mites. Growers would be encouraged to make this application for mite control as soon as mites appeared in numbers on the trees and to repeat the application if necessary. Wettable sulfur sprays (4-100) were also promising in these tests for control of clover mites.

Preliminary observations indicated that benzene hexachloride might be very effective against the woolly apple aphid.

C. Golden Delicious Apples, Gow Ranch, Beaumont; Red Delicious Apples, Barnes Ranch, Julian.

Additional tests were conducted on apples to compare the efficiencies of DDT dust and spray programs and to evaluate commercial DDT spray concentrates both when used alone and when used in combination with a deposit building supplement.

The DDT-oil-talc (4-0.5-95.5) dust mixture applied in the last four covers to a block of Golden Delicious apple trees was significantly less effective than a DDT spray schedule of Gesarol AK40 (1-1/4-100) applied to an adjacent block at the same times. Mites built up more rapidly on the dusted trees.

Of three DDT spray concentrates supplied for testing on Red Delicious apples in San Diego County two were very effective while the third gave poor control but was still superior to the grower's arsenate spray program. Gesarol AK40 (1 1/4-100) and Niagra-50 Spray Concentrate (1-100) gave excellent control and the use of the deposit builder (DDT Depositor) with one quart of summer oil did not appreciably increase the effectiveness of these sprays. The third DDT concentrate (no longer available) gave poorer control when used with the DDT Depositor and oil. DDT residues at harvest were less than 5 parts per million even when the apples were sprayed with the DDT concentrate plus the deposit builder and oil.

D. Removal of DDT surface residues.

Although the amounts of DDT residual on the apple fruits at harvest were considerably under the provisional tolerance of 7 parts per million, it was considered desirable to undertake several wash tests to confirm the results of tests made in 1944. The tests were made in a flood-type tandem washer of recent manufacture. Duplicate or triplicate samples of 30 apples each were taken for the residue analyses from the fruit passed through each experimental wash mixture. An additional sample was taken and the apples placed in cold storage for subsequent examinations. The types of spray deposits, wash mixtures and results of the DDT residue analyses of washed fruits are summarized in Tables 7 and 8.

In practically all cases the residual DDT was reduced to less than one part per million wet weight. This is in essential agreement with the results of similar tests in 1944. However, the percent of DDT removed was considerably less in the 1945 tests. This may be explained by the fact that the apples used in the 1944 wash tests carried as high as 7 parts per million of DDT as surface residue as compared to an average of 2 parts per million on the apples used in the current studies.

Tennessee ball clay was the only extending material which when in composition with DDT appeared to interfere appreciably with the removal of DDT residues by sodium silicate washes. Heating the wash mixture to as high as 100° Fahrenheit did not increase the effectiveness of the sodium silicate wash. Materials such as IN-151-P and Triton X-100 were promising as washing agents although used in very small amounts.

Table 1. Codling Moth and Pacific Mite Test on Bartlett Pears, Little Rock

Note: 1) A calyx spray of Gesarol AK20 (5-100) was applied to the entire test block on April 30
2) Harvest - August 25-27.

Materials (unit of measure)	Composition and schedules of treatments — Cover spray: First May 18	Second June 12	Third July 5	Fourth July 24	Fifth August 10	Number of single tree replicates	Total crop (Per cent) Wormy	Clean	Mite injury — Leaf drop per unit area per tree[1] Aug.14	Aug.14-21	DDT surface residues — Leaves Micrograms per cm² After cover sprays (3,4,5)	Fruits p.p.m. wet weight August 24
1. DDT (Aerosol)[2]-kaolin clay[3] (50-50)[4] (lbs.)	2	2	2	2	2	6	1.5	98.5	209	217	17.4	13.2
2. DDT (Aerosol)-kaolin clay (50-50) (lbs.)	1-1/2	1-1/2	1-1/2	1-1/2	1-1/2	6	3.3	96.7	213	232	13.1	11.0
3. DDT (Aerosol)-kaolin clay (50-50) (lbs.)	1	1	1	1	1	6	9.9	90.1	315	267	7.8	8.3
4. DDT (Aerosol)-kaolin clay (50-50) (lbs.)	1	1	1	1	1	6	5.4	94.6	97	107	---	7.0
Light medium emulsive oil (gals.)	1	1	-	-	-							
5. DDT (Aerosol)-kaolin clay (50-50) (lbs.)	1	1	1	1	1	6	10.0	90.0	73	38	5.4	6.1
DN-111[5] (lbs.)	1/2	1/2	1/2	1/2	1/2							
Colloidal Z-1[6] (ozs.)	5	5	5	5	5							
6. DDT (Aerosol)-kaolin clay (50-50) (lbs.)	1	1	1	1	1	6	8.1	91.9	55	31	5.4	6.6
DN-211[7] (lbs.)	1/2	1/2	1/2	1/2	1/2							
Colloidal Z-1 (ozs.)	5	5	5	5	5							
7. Wettable fused sulfur-DDT[8] (lbs.)	5	5	5	5	5	6	5.3	94.7	57	18	---	---
8. DDT (Aerosol)-kaolin clay (50-50) (lbs.)	1	-	-	-	-	6	12.6	87.4	64	47	3.4	5.4
DDT (Aerosol)-xanthone[9] kaolin clay (1-8-1)[4] (lbs.)	-	2-1/2	2-1/2	2-1/2	2-1/2							
Genifilm A[10] (ozs.)	-	8	8	8	8							
Kerosene (qts.)	-	1	1	1	1							
9. Ryanex (100%)[11] (lbs.)	6	6	6	6	6	6	18.4	81.6	574	338	---	---
Blood albumin spreader (ozs.)	2	2	2	2	2							
10. Compound 603[12] (lbs.)	3/4	3/4	3/4	3/4	3/4	8	40.2	59.8	352	187	---	---
Bentonite[13] (lbs.)	2	2	2	2	2							
Light medium emulsive oil (qts.)	2	2	2	2	2							

1/ An area equal to 2 (12" x 48") with the lengths oriented along a line between 12" and 60" from the tree trunk on both the east and west sides.

2/ A grade of DDT obtained from the Hercules Powder Company which had a setting point of 103.2° C.

3/ Supplied by the Huntley Mines, Bigpine, California.

4/ Milled in laboratory hammer mill through screen sequence 1/16 E. B. (herring bone slot), .035 H. B. and .035 H. B. following manual premixing.

5/ A proprietary material containing not less than 20 per cent of the dicyclo hexylamine salt of dinitro-o-cyclohexylphenol supplied by the Dow Chemical Company.

6/ A spray supplement supplied by the Colloidal Products Corporation.

7/ An experimental dinitro compound supplied by the Dow Chemical Company.

8/ A composition supplied by the Stauffer Chemical Company which contained 10 per cent technical DDT fused with elemental sulfur and a small amount of a wetting agent.

9/ A proprietary mixture of dibenzo gamma pyrone and dibenzo gamma pyrone derivatives supplied by the General Chemical Company and marketed as Genicide.

10/ A spray supplement supplied by the General Chemical Company for use with Genicide in spray suspensions.

11/ A botanical material supplied by Merck & Company, Inc.

12/ An experimental nicotine compound supplied by the General Chemical Company.

13/ Panther Creek bentonite obtained from the American Colloid Company.

Table 2. Semi-commercial Field Test with DDT
Codling Moth Test on Bartlett Pears, Little Rock

Note: Harvest - August 17-20

Composition and schedules of treatments	Calyx sprays		Cover sprays										
	First	Second	First	Second	Third	Fourth	Size	Number	Total crop (per cent)			Per cent wormy fruits with calyx entries	DDT surface residues on fruits expressed as p.p.m. wet weight
Materials (unit of measure)	April 27	May 9-10	June 2	June 21	July 13	August 2	of plots (acres)	of count trees	Wormy Calyx	Wormy Side	Clean		August 17
1. DDT (Tech)[14]-ball clay[15] (50-50)[16] (lbs.)	-	-	1	1	1	1	1-1/4	12	6.4	1.9	91.7	77	5.3
Wettable sulfur (lbs.)	-	-	4	-	-	-							
2. DDT (Tech)-ball clay (50-50) (lbs.)	1	-	1	1	1	1	1-1/4	12	4.3	2.1	93.6	67	5.0
Wettable sulfur (lbs.)	-	-	4	-	-	-							
3. DDT (Tech)-ball clay (50-50) (lbs.)	-	1	1	1	1	1	1-1/4	12	3.7	1.2	95.1	76	5.0
Wettable sulfur (lbs.)	-	-	4	-	-	-							
4. DDT (Tech)-ball clay (50-50) (lbs.)	1	1	1	1	1	1	1-1/4	12	1.3	1.2	97.5	52	5.1
Wettable sulfur (lbs.)	-	-	4	-	-	-							
5. Acid lead arsenate (lbs.)	4	4	3	3	3	3	5	12	30.9	21.5	47.6	59	---
Ortho K NW Flowable[17] (pts.)	1	1	8	8	-	-							

14/ A technical grade of DDT obtained from the E. I. DuPont de Nemours & Company, Inc. which had a setting point of 87.7° C.

15/ Tennessee ball clay #1 obtained from the L. H. Butcher Company.

16/ Milled in a laboratory hammer mill through screen sequence 1/16 H. B., 1/16 H. B., and 1/16 H. B. following premix in ribbon mixer.

17/ Summer oil emulsion obtained from the California Spray Chemical Corporation.

Table 3. Semi-commercial Field Test with DDT
Codling Moth and Pacific Mite Test on Bartlett Pears, Little Rook

Note: Harvest - August 28-29

Materials (unit of measure)	Composition and schedules of treatments: First calyx April 27	Second calyx May 12	First cover June 12	Last three covers July 5,24 August 13	Size of plots (acres)	Number of count trees	Total Crop (per cent): Wormy calyx	Wormy side	Clean	Mite injury: Leaf drop per unit area per tree[1] August 24
1. DDT (Teoh)[14]-calcium silicate[18]/(50-50)[16] (lbs.)	1	1	1	1	1-1/4	10	0.3	0.5	99.2	480.5
2. DDT (Teoh)-calcium silicate (50-50) (lbs.)	1	1	1	1	1-1/4	10	0.6	1.6	97.8	195.4
Ortho K NW Flowable (pts.)	-	-	8	-						
3. DDT (Teoh)-calcium silicate (50-50) (lbs.)	1	1	1	1	1-1/4	10	0.3	0.8	98.9	35.3
DN-111 (lbs.)	-	-	3/4	-						
Colloidal Z-1 (ozs.)	-	-	5	-						
4. DDT (Tech)-calcium silicate (50-50) (lbs.)	1	1	1	1	1-1/4	10	0.2	0.7	99.1	190.6
Xanthone (lbs.)	-	-	2	-						
Genifilm A (ozs.)	-	-	6	-						
Kerosene (qts.)	-	-	1	-						
5. Acid lead arsenate (lbs.)	4	4	3	3	5	10	22.0	23.8	54.2	75.2
Ortho K NW Flowable (pts.)	1	1	8	-						

18/ A precipitated hydrated calcium silicate furnished by the Pittsburg Plate Glass Company and designated as Silene EF.

Table 4. Effect of Grade of DDT and Amount and Kind of Extending Material
Codling Moth Test on Rome Beauty Apples, Oak Glen

Note: 1) A calyx spray of Gesarol AK40 (1 1/4-100) was applied to four blocks of the test on May 19. The remaining three blocks received no calyx application.
2) Harvest - October 9-11

Composition of cover sprays Materials	First-June 2 Second-June 15 Third-June 29 Fourth-July 26 Fifth-August 13 Sixth-August 24	Number of single tree replicates	Total crop: Per cent Wormy	Per cent Stung	Per cent Clean	Worms per 100 fruits	Stings per 100 fruits	DDT surface residues on fruits expressed as p.p.m. wet weight: Oct. 5	Oct. 17[19]
1. DDT (o.p.)[20]-amorphous silica[21] (35-65)[22]	1.4 lbs.	7	0.3	1.6	98.1	0.3	1.7	3.0	0.9
2. DDT (Aerosol)[2]-amorphous silica (40-60)[22]	1.4 lbs.	7	0.9	1.4	97.7	0.9	1.5	3.6	2.0
3. DDT (Tech)[14]-amorphous silica (50-50)[22]	1.4 lbs.	7	0.3	1.1	98.6	0.3	1.1	3.9	1.7
4. DDT (Tech)-amorphous silica (25-75)[22]	2.8 lbs.	7	0.4	1.4	98.2	0.4	1.5	3.5	1.8
5. DDT (Tech)-amorphous silica (12 1/2-87 1/2)[22]	5.6 lbs.	7	0.1	0.5	99.4	0.1	0.5	3.8	2.0
6. DDT (Tech)-amorphous silica (50-50) remilled[23]	1.4 lbs.	7	0.1	0.7	99.2	0.1	0.8	4.6	2.0
7. DDT (Tech)-calcium silicate[18] (50-50)[22]	1.4 lbs.	7	0.1	0.6	99.3	0.1	0.6	4.0	3.1
8. DDT (Tech)-ball clay[15] (50-50)[22]	1.4 lbs.	7	0.6	2.0	97.4	0.6	2.2	3.4	1.6
9. DDT (Tech)-kaolin clay[3] (50-50)[22]	1.4 lbs.	7	0.1	1.4	98.5	0.1	1.4	5.1	2.7
10. Gesarol AK40[24]	1.4 lbs.	7	0.5	1.5	98.0	0.5	1.8	3.8	1.7
11. DDT-Veegum (10-90)[25]	5 lbs.	7	0.6	2.0	97.4	0.6	2.4	5.2	2.5
12. Acid lead arsenate	3 lbs.	6	16.9	10.6	72.5	19.6	22.2	---	---

19/ The October 17 fruit samples were taken from a single tree replicate of each treatment whereas the October 5 samples were taken from the seven single tree replicates of each treatment.

20/ A recrystallized grade of DDT furnished by the Pennsylvania Salt Manufacturing Company which had a setting point of 106.7° C.

21/ An extender supplied by the Johns-Manville Corporation and designated as Celite No. 209.

22/ Milled in a laboratory hammer mill through the screen sequence 1/16 H. B., .035 H. B. and .020 H. B. following manual premixing.

23/ Milled in a laboratory hammer mill through the screen sequence 1/16 H. B., .035 H. B., .027 H. B., .020 H. B., .020 H. B. and .020 H. B. following manual premixing.

24/ A composition obtained from the Geigy Company, Inc. which contained 40 per cent technical grade DDT and 60 per cent of unspecified extending materials.

25/ Supplied by the R. T. Vanderbilt Company, Inc.

Table 5. Effect of Supplements on the Efficiency of DDT and Tests of other Organic Insecticides. Codling Moth Test on Rome Beauty Apples, Oak Glen

Note: 1) A calyx spray of Gesarol AK40 (1 1/4-100) was applied to four blocks of the test on May 19. The remaining three blocks received no calyx application.
2) Harvest - October 10-12

Materials (unit of measure)	Composition of cover sprays First-June 5-9 Second-June 19 Third-July 9 Fourth-August 4 Fifth-August 22	Number of single tree replicates	Total crop Per cent Wormy	Stung	Clean	Worms per 100 fruits	Stings per 100 fruits	DDT surface residues on fruits expressed as p.p.m. wet weight Oct. 5	Oct. 17[19]
1. DDT (Aerosol)[2]-ball clay[15] (50-50)[21] (lbs.)	1.1	7	1.4	4.5	94.1	1.6	5.0	2.0	1.3
2. DDT (Aerosol)-ball clay (50-50) (lbs.)	1.1	7	1.8	3.4	94.8	1.8	4.2	2.0	0.7
Blood albumin spreader (ozs.)	1								
3. DDT (Aerosol)-ball clay (50-50) (lbs.)	1.1	7	2.6	6.9	91.5	2.6	7.2	2.6	1.1
Zinc sulfate monohydrate (ozs.)	6								
Genifilm C[27] (10 per cent aqueous solution) (pts.)	1/4								
4. DDT (Aerosol)-ball clay (50-50) (lbs.)	1.1	7	1.1	4.9	94.0	1.2	6.7	2.0	1.1
Light medium oil (2 per cent B-1956)[28] (qts.)	1								
5. DDT (Aerosol)-ball clay (50-50) (lbs.)	1.1	7	1.3	4.2	94.5	1.4	4.8	1.9	0.1
Light medium oil (2 per cent B-1956) (pts.)	1								
Animal glue (6 per cent aqueous solution) (pts.)	1/2								
6. DDT (Aerosol) (lbs.)	.55	7	1.7	3.7	94.6	1.8	4.4	1.2	0.5
Velsicol AR60[29] (qts.)	1-1/2								
7. Acid lead arsenate (lbs.)	8	7	9.5	8.4	82.1	10.7	14.0	---	---
B-1966 (ozs.)	3								
8. Z39-Cherokee clay-Triton X-120 (50-49.3-0.7)[30] (lbs.)	2	7	8.7	5.0	86.3	9.2	7.5	---	---
9. He 761[31] (lbs.)	2	7	5.2	8.1	86.7	6.6	11.0	---	---
10. Benzene hexachloride-soapstone (10-90)[32] (lbs.)	6	2	24.7	3.9	71.4	26.7	6.3	---	---

26/ Milled in a laboratory hammer mill through the screen sequence 1/16 H. B., 1/16 H. B. and .036 H. B. following manual premixing.

27/ A spray supplement supplied by the General Chemical Company particularly for use with Genioide in spray suspensions.

28/ A proprietary emulsifying agent containing a phthalic glycerol alkyd resin supplied by the Rohm and Haas Company.

29/ An aromatic petroleum fraction comprised principally of di- and trimethyl naphthalenes supplied by the Velsicol Corporation.

30/ A composition of dichloro diphenyl dichloroethane supplied by the Rohm and Haas Company.

31/ An experimental compound supplied by the Rohm and Haas Company.

32/ Supplied by Chemurgic Corporation and designated as HEX.

Table 6. Semi-commercial Field Test with DDT
Codling Moth Test on Rome Beauty Apples, Oak Glen

Note: 1) A calyx and six cover sprays were applied by the grower to each treatment plot. The timing of sprays followed the regular spray schedule for the area.
2) Harvest - October 12-26

Materials	Dosage per 100 gallons	Size of plot (acres)	Number of count trees	Total crop (per cent)			DDT surface residues on fruits expressed as p.p.m. wet weight October 29
				Wormy	Stung	Clean	
1. Gesarol AK40[24]	1-1/4 lbs.	5-1/2	16	1.2	1.7	97.1	2.1
2. DDT (Tech)[14]-kaolin clay[3] (50-50)[16]	1 lb.	2-1/2	16	2.0	3.6	94.4	1.2
3. DDT (Tech)-amorphous silica[21] (50-50)[16]	1 lb.	2-1/2	16	2.1	3.7	94.2	1.8
4. Acid lead arsenate	3 lbs.	5	8	12.0	23.8	64.2	---

Table 7. Removal of DDT Surface Residues from Apples with Sodium Silicate Washes.

Note: Flood-type tandem washer[33/]
Prewash tank-sodium silicate[34/] (80 pounds to 100 gallons)
Main tank-water only

Spray treatments[35/]	Dosage in all cover sprays	DDT surface residues on fruits expressed as p.p.m. wet weight			Per cent DDT surface residue removed	
		Unwashed	Washed 80°F	Washed 100°F	80°F	100°F
1. DDT (c.p.)-amorphous silica (35-65)	1.4 lbs.	0.9	---	0.1	--	89
2. DDT (Aerosol)-amorphous silica (40-60)	1.4 lbs.	2.0	0.5	0.4	75	80
3. DDT (Tech)-amorphous silica (50-50)	1.4 lbs.	1.7	0.7	0.6	59	65
4. DDT (Tech)-amorphous silica (25-75)	2.8 lbs.	1.8	---	0.2	--	89
5. DDT (Tech)-amorphous silica (12 1/2-87 1/2)	5.6 lbs.	2.0	0.3	0.6	85	70
6. DDT (Tech)-amorphous silica (50-50) remilled	1.4 lbs.	2.0	0.7	0.2	65	90
7. DDT (Tech)-calcium silicate (50-50)	1.4 lbs.	3.1	0.4	0.2	87	94
8. DDT (Tech)-ball clay (50-50)	1.4 lbs.	1.6	1.0	1.2	38	25
9. DDT (Tech)-kaolin clay (50-50)	1.4 lbs.	2.7	1.1	0.6	59	78
10. Gesarol AK40	1.4 lbs.	1.7	0.4	0.6	76	65
11. DDT-Veegum (10-90)	5 lbs.	2.5	0.8	0.8	68	68
Average	----	2.0	0.7	0.5	68	74

33/ A BADD washer with a heated prewash tank unit, an unheated main tank unit, a water rinse tank unit and a velour roller drier unit manufactured by the Bean-Cutler Division of the Food Machinery Corporation.

34/ An alkaline liquid silicate (58.5° Baumé) with an approximate alkali-silica ratio of 1:1.60 manufactured by the Philadelphia Quartz Company and designated as Brand B-W.

35/ See footnotes of Table 4.

Table 8. Removal of DDT Surface Residues from Apples.

Note: Apples sprayed in six covers with DDT (Tech)-amorphous silica (50-50)[36]
at the rate of 1.4 pounds per 100 gallons
Flood-type tandem washer[33]
Prewash tank-wash mixture
Main tank-water only

Wash materials (unit of weight)	Amount per 100 gallons	Temp. of wash mixture	DDT surface residues on fruits expressed as p.p.m. wet weight		Per cent DDT surface residue removed
			Unwashed	Washed	
1. Sodium silicate[34] (lbs.)	80	65°F	1.7	0.55	68
2. Sodium silicate (lbs.)	80	80°F	1.7	0.7	59
3. Sodium silicate (lbs.)	80	100°F	1.7	0.6	65
4. IN-181-P[37] (ozs.)	1	65°F	1.3	0.55	58
5. Triton X-100[38] (ozs.)	1	67°F	1.3	0.7	46
6. Triton X-155M[39] (ozs.)	1	65°F	1.3	1.3	0
7. Trisodium phosphate (lbs.)	3	70°F	1.3	1.0	23
8. Trisodium phosphate (lbs.) IN-181-P (ozs.)	3 1/3	68°F	1.3	0.8	38

36/ See footnotes of Table 4 concerning this mixture.

37/ A powder containing 51 per cent sodium lauryl sulfate obtained from the E. I. DuPont de Nemours and Company, Inc.

38/ A polyethylene glycol alkyl aryl ether emulsifying agent supplied by the Rohm and Haas Company.

39/ An emulsifying agent which is dimeric dialkyl phenoxy polyethoxy ethanol supplied by the Rohm and Haas Company.

COLORADO

George M. List, Colorado Agricultural Experiment Station, Fort Collins and J. H. Newton, Bureau of Plant and Insect Control, Paonia.

Codling Moth Control in Colorado - 1945

The investigational studies for the control of codling moth on pears and apples was again set up as a cooperative project of the Colorado Experiment Station and the State Bureau of Plant Insect Control.

The project consisted of two definite lines of endeavor, viz: (1) Experimental replication of spray materials and schedules on pears at Clifton, and (2) grower test plots on pears and apples in Mesa, Fremont and Delta counties.

Seasonal Conditions: Codling moth emergence started 7 to 10 days later and was materially less in total population than for the season of 1944. The intermittant cool, rainy periods during May, and a comparatively cool June, were seasonal conditions that contributed to a moderate codling moth infestation for the first brood. The weather conditions during July and August were favorable for normal moth activity.

Generally speaking, the standard spraying treatments (lead arsenate-kerosene-soap or fixed nicotine spray mixtures) gave controls far above those reported in 1944.

(1) Experimental Spray Tests on Pears

The experiment plan, as in 1944, consisted of 72 double tree plots, in which 12 different spraying treatments were replicated 6 times.

Spraying dates:

First Brood Sprays		Second Brood Sprays	
Calyx spray	May 10		
1st cover spray	May 20	5th cover spray	July 7
2nd cover spray	May 29	6th cover spray	July 17
3rd cover spray	June 9	7th cover spray	July 25
4th cover spray	June 19	8th cover spray	Aug. 7

Summary of Total Season's Fruit for All Plots
(Includes Thinnings, Windfalls, and Harvest Fruit)

Treatment No.	Spray schedules and materials Quantities per 100 gallons of water	Percent wormy fruit	Percent stung fruit	Percent total worms as calyx worms
0	DDT (Gesarol AKZ-40) 2# Gesofloc spreader and sticker 1 pt. Applied in calyx and 8 cover sprays (.8# actual DDT-100)(Second consecutive year DDT used on these trees)	0.1	0.18	5%
1	Calyx spray, lead arsenate only. Cover sprays 1-4 inclusive lead arsenate 3#, kerosene 1 pt., summer oil 2 qt. (Superla). In second brood cover spray, 5 to 8 inclusive, summer oil omitted, kerosene increased to 2 qt.	9.54	0.73	51%
2	DDT same as No. 0 (Harvest fruit on these trees were 61% wormy in 1944 following lead arsenate-kerosene-soap spray schedule)	0.33	0.52	12%
3	Calyx spray, Kryocide 3# followed by 8 cover sprays-Kryocide 3# summer oil (Superla) 2 qt.	3.44	0.58	58%
4	BL 155 with DDT (formulation) 2# plus 2 qt. summer oil for 8 cover sprays. Oil omitted from calyx spray. (Formulation contains 17% DDT, therefor 2# equals .34# actual DDT-100 gallons.)	0.81	0.38	44%
5	He-761 1 1/2# Calyx and 8 cover sprays. Summer oil (Superla) 2 qt. in first cover spray. Oil omitted from following sprays due to foliage injury.	7.92	1.04	53%
6	DDT 25% (Dupont) 3.2# Calyx and 8 cover sprays (Equals .8# actual DDT to 100 gal.)	0.16	0.13	18%
7	Lead arsenate 2#; DDT 2# (Gesarol AKZ-40) Gesofloc-sticker-spreader 1 pt. Calyx and 8 cover sprays. (Equals .8# actual DDT to 100 gal.)	0.10	0.34	14%
8	B.L. 155 2#, summer oil (Superla) 2 qt. Calyx spray lead arsenate 3# for 8 cover sprays (second consecutive year on these trees).	5.81	0.47	63%

Continued

Treatment No.	Spray schedules and materials Quantities per 100 gallons of water	Percent wormy fruit	Percent stung fruit	Percent total worms as calyx worms
9	DDT same as No. 0, except 2-4-6 and 8th cover sprays omitted. Calyx and 4 cover sprays applied.	1.49	1.11	11%
10	DDT (Gesarol AKZ-40) 1#, plus 1/2 pt. Gesofloc spreader and sticker, Calyx and 8 cover sprays total amount of actual DDT applied same as in No. 9 except it was distributed throughout season. (Equals 0.4# actual DDT to 100 gal.)	0.80	1.18	17%
11	DDT (Gesarol AKZ-40) 3# plus 1 pt. Gesofloc sticker and spreader. Calyx and 8 cover sprays (Equals 1.2# actual DDT to 100 gal.)	0.13	0.22	11%

Mite Control: Summer oil used with lead arsenate, Kryocide, Black Leaf 155 DDT formulation, and Black Leaf 155 (see schedules No. 1, 3, 4, and 8) controlled red spider infestation.

In the DDT spray treatments the addition of 4, 6, and 8 ounces of DN-111 (Dinitro-o-Cyclohepylphenol, Dicychlohexylamine Salt) to the second, third, and fourth cover sprays held the red spider infestation in check until after harvest. In 10 to 14 days following harvest the red spider infestation built up to the point of causing some defoliation.

In plot 9, where only one application of DN-111 was made in the third cover spray, defoliation by red spider became apparent by August 7. An immediate application of DN-111 (8 oz. to 100 gal.) in the eighth cover spray controlled the infestation. It is probable that the same rate of application used in the early cover sprays might have solved the mite problem for the season.

Codling moth control: Codling moth control was comparatively excellent throughout all spray treatments, when considered in the light of the previous years' experience, when 8 cover sprays of lead arsenate-kerosene-soap resulted in 61% wormy harvest fruit. The use of DDT in the several spraying schedules consistently produced superior control over the non-DDT spray mixtures.

Fruit Size: Randomized samples of 50 pears weighed from each tree in every plot, indicated a significant reduction of fruit size where summer oil had been used through the season.

(2) Grower Test Plots

Grower test plots were conducted in mesa County on pears, and in Delta, Larimer, and Fremont counties on apples. Quantities and mixtures of spray materials were approximately the same as in the experimental plots as recorded in section (1) of this report.

Grower	Fruit	Spray Treatment Materials, etc.	Percent wormy fruit	Percent stung fruit
M. L. Dilley	Bartlett	Lead arsenate-oil-		
Clifton	Pears	kerosene-soap	8.0	1.0
		DDT	0.1	0.1
(Oil used in first brood		DDT (calyx spray		
spray) Total 8 cover sprays		omitted)	0.0	0.0
Pond Orchards	Bartlett	Composite of 4 orchards		
Clifton	Pears	A. Lead arsenate-oil-		
		kerosene	2.8	0.1
5 & 6 cover sprays		B. BL 155, oil	1.3	0.2
		C. DDT	0.7	0.7
		D. Kryocide	1.8	0.4
Paul Hofer	Apples	DDT 2/	.8	11
Paonia	Delicious	BL 155, oil	31	4
6 cover sprays		BL 155, DDT, oil	18	7
		Lead arsenate, oil	21	13
John Patton	Apples	BL 155, oil	15.0	13.0
Hotchkiss	Romes	BL 155, DDT, oil	9.0	11.0
		DDT 2/	0.6	2.4
5 cover sprays		Lead arsenate, DDT	3.0	11.0
		Lead arsenate, kerosene		
		oil	16.0	15.0
Neal Hadley	Apples	Lead arsenate-kerosene		
Paonia	Delicious	soap	16.0	24.0
6 cover sprays		DDT 2/	3.3	4.0
Van Gorder	Apples	Speed sprayer 6 cover		
Paonia		sprays		
		DDT 2/ Jonathans	0.4	0.2
		Delicious	0.2	1.6
		5 cover sprays		
		DDT 2/ Jonathans	0.3	0.4
		Delicious	0.1	0.2
		6 cover sprays-Jonathan		
		Lead arsenate-kerosene soap	4.0	6.0

2/ DDT was not available until time for second cover spray.

Grower	Fruit	Spray Treatment Materials, etc.	Percent wormy fruit	Percent stung fruit
Becco Bors.	Apples Jonathans	Calyx and 1st. cover lead arsenate 1/		
		DDT 2/ 40% 2# -100	0.5	1.0
		DDT 2/ 40% 1# -100	1.0	1.7
		BL 155, oil	7.4	1.0
	Ben Davis	Lead arsenate	6.9	7.1
		Kryolite	6.2	6.1
C. E. White Penrose	Apples Romes	DDT	6.4	12.5
		Kryolite	20.8	12.9
		Lead arsenate	21.4	12.9
C. Buckingham Loveland	Apples Jonathan	Lead arsenate-kerosene soap	29.8	11.6
		BL 155, oil	16.5	2.7
		Lead arsenate 2#		
		DDT 1# to 100	19.4	4.5
		DDT 1# to 100	5.0	2.4

1/ Calyx and first cover spray lead arsenate.

2/ DDT was not available until time for second cover spray

In the grower test plots DDT proved superior for codling moth control over all other spray schedules. No particular mite or red spider infestations developed in the apple orchards where DDT sprays were applied, except in the Becco orchard at Canon City. It is recognized that these data cover only one season's experience and also that the mite populations have a tendency to increase with the use of DDT. While DDT as an insecticide for the control of codling moth shows great possibilities, its use is not being recommended for the season of 1946 due to the uncertainty of meeting residue tolerance requirements. Suggestions relative to its use will be issued for the guidance of those who insist upon giving it a trial in 1946.

DDT Residue Studies

An analysis was made of the DDT deposit at harvest time on samples of fruit from each of the spray plots and orchards.

In the Dilley Bartlett pear orchard the residue ranged from 3.061 ppm in the plots that received only 4 cover sprays of .8 pound of DDT per 100 gallons to 7.047 ppm in the plots that received 8 cover sprays of 1.2 pounds per 100 gallons. This was the only case where the residue on Bartlett pears

was over the 7 ppm. However, in the same orchard Keifer pears sprayed with .8 pound of DDT to 100 gallons carried a deposit of 4.492 ppm. In a Rome Beauty orchard 5 cover sprays of .8 pound to 100 gallons gave a deposit of 3.256 ppm while 5 cover sprays of a combination of Black Leaf 155 and DDT with oil which gave a dilution of .34 pound of DDT to 100 gallons resulted in a deposit of 6.437 ppm. In a Jonathan orchard 6 cover sprays of 1 pound of DDT to 100 gallons gave a deposit of 7.402 ppm. while in the same orchard 6 cover sprays consisting of lead arsenate 2 pounds and DDT .4 pound to 100 gallons gave a deposit of 8.760 ppm.

A number of materials were used in washing solutions in the laboratory in an attempt to remove DDT. None of these consistently removed any considerable percentage. In orchard tests brushing the fruit with a peach defuzzing brusher, washing in the standard hydrochloric acid, and washing in a 2 percent lye solution, in a solution of Vatsol 6 pounds to the 100 gallons and with Vatsol 6 pounds to 100 gallons plus 2 percent lye, all failed to remove consistently any considerable percentage.

CONNECTICUT

R. B. Friend, Connecticut Agricultural Experiment Station, New Haven.

CODLING MOTH, 1945

Oviposition: The weather conditions probably were responsible for a prolonged emergence period, and temperatures were not favorable to oviposition in late May and early June. Most of the first brood larval damage occurred in late June and in July.

Infestation: In our experimental orchards at Mount Carmel and vicinity the infestation was low, less than 4 percent in the sprayed blocks. In a commercial orchard at Branford where the damage has been fairly heavy in late years, due to improper orchard management and spraying, the damage was reduced in 1945 partly because of unfavorable temperatures during the oviposition period and partly because of improved spraying. Eight or 10 commercial orchards had an increased infestation in 1945, but the spray coverage was evidently not good in late June and July. In all but two cases the infested blocks were close to packing sheds. We have no evidence that with a good spray program arsenate of lead will not control the codling moth in Connecticut.

The low infestation in our experimental orchards has rendered the results of our reduced schedules and DDT applications inconclusive.

DELAWARE

L. A. Stearns, Delaware Agricultural Experiment Station, Newark.

Spray Program - Knapp Orchard - McIntosh Variety - Nassau, Delaware - 1945*

Spray Dates	Lead Arsenate (3 lbs.) Plot	DDT (.6 lb.) Plot
	Materials used per 100 Gallons	
(Petal Fall) 4/8	Lead Arsenate - 3 lbs., Lime - 5 lbs., Flotation Sulfur (45%) - 10 lbs.	
4/17	"	"
4/24	"	"
5/11	"	"
5/17	Lead Arsenate - 3 lbs., Lime - 5 lbs., Copper Sulfate - 1 lb.	Gesarol AKZ40 - 1½ lbs., Gesafloc - 3/4 pt., Fermate - 1 lb.
5/24	Lead Arsenate - 3 lbs., Lime - 3 lbs., Summer Oil - 3 qts., Tubacide - 1 pt.	"
5/30	Lead Arsenate - 3 lbs., Lime - 3 lbs., Copper Sulfate - 1 lb.	"
6/12	Lead Arsenate - 3 lbs., Lime - 3 lbs., Copper Sulfate - ½ lb.	Gesarol AK40 - 1½ lbs.
6/27	"	Gesarol AKZ40 - 1½ lbs., Gesafloc - 3/4 pt.
7/15	Lead Arsenate - 3 lbs., Lime - 3 lbs., Copper Sulfate - ½ lb., Summer Oil - 3 qts., Black Leaf 40 - 1 pt.	"
7/30	Lead Arsenate - 3 lbs., Lime - 3 lbs., Copper Sulfate - ½ lb.	"

* Work of P. L. Rice, Department of Entomology, Delaware Agricultural Experiment Station.

Comments and Results - Spray Program - Knapp Orchard - McIntosh Variety - Nassau, Delaware - 1945

Orchard block, 5 x 35 rows, 15-year-old McIntosh, planted 40' x 40'; divided into 2 plots of 5 x 15 rows (Lead Arsenate) and 5 x 20 rows (DDT); 10 count trees in each plot with 18 of these 20 trees in center row; applications with speed sprayer, as listed elsewhere; dropped fruit examined July 13 and July 24 and 25; harvest records and red mite counts, August 7 and 9.

Bait Pan Collections (1904 moths) in relation to Spray Applications

Periods	Days	Number of Moths	Number per Day	Percent of Total	Large Collections during Periods	Number of Sprays
4/24 to 5/7	14	16	1	1	First moths 4/24 5/1-5, 5/5-4	3
5/8 to 5/22	15	1200	80	63	5/8-119, 5/13-288, 5/14-234, 5/17-102, 5/22-231	2
5/23 to 6/7	16	255	16	13	5/26-84	2
6/8 to 6/22	15	304	20	16	6/12-148	1
6/23 to 7/31	39	129	3	7	7/31-14	3

(Procedure set forth in U.S.D.A. - ET-215 followed in sampling fruit)

Points of Comparison on Control of Codling Moth & Red Mite	Lead Arsenate (3 lbs.) Plot	DDT (.6 lb.) Plot
Total apples (including dropped and harvested fruit)	42,614	52,390
" " examined (including dropped and harvested fruit)	4,470	4,500
Per cent clean	39	43
Per cent wormy	28	36
Per cent stung	33	21
Extra worms in wormy fruit	5,682	7,909
" stings " " "	14,780	9,758
Total worms	17,244	26,187
Number of worms per 100 apples	41	51
Total stings	40,727	25,891
Number of stings per 100 apples	96	51
Residue on harvested fruit (5 samples of 10 apples each) grain/lb.	(AS_2O_5) .055	.055
Residue on harvested fruit (5 samples of 10 apples each) ppm	(AS_2O_5) 8	8
Average number of preharvest dropped apples per tree	66	1,027
Average number of red mites per leaf	16*	110**
" " " harvested bushels per tree (including dropped fruit)	26	25
" " " apples per bushel	136	166

* injury very light ** injury heavy

Spray Program - Richardson-Kelly Orchard - Red Delicious Variety - Rising Sun, Delaware - 1945*

Spray Dates	Plot 1 (Lead - 4 lbs.)	Plot 2 (Lead-Oil-Nicotine)	Plot 3 (DDT - .8 lb.)	Plot 4 (DDT - .4 lb.)	Plot 5 (DDT-.2 lb.; Lead-2 lbs.)
	Materials used per 100 Gallons				
(Petal Fall) 4/9	Lead Arsenate - 3 lbs., Lime - 5 lbs., Flotation Sulfur (45%) - 10 lbs.				
4/16	Lead Arsenate - 4 lbs., Fermate - 1½ lbs., Grasselli S.S. - 1 oz.				
5/7	"		Gesarol AKZ40- 2 lbs. Gesafloc- 1 pt. Fermate- 1½ lbs.	Gesarol AKZ40- 1 lb. Gesafloc- ½ pt. Fermate- 1½ lbs.	Gesarol AKZ40- ½ lb. Gesafloc- ¼ pt. Lead Ars.- 2 lbs. Fermate- 1½ lbs.
5/15	Lead Ars.- 4 lbs. Lime- 4 lbs. Grasselli S.S.- 1 oz.	Lead Ars.- 4 lbs. Lime-2 lbs. Summer Oil- 3/4 gal. Bl. Leaf 40- 3/4 pt.	Gesarol AKZ40- 2 lbs. Gesafloc- 1 pt.	Gesarol AKZ40- 1 lb. Gesafloc- ½ pt.	Gesarol AKZ40- ½ lb. Gesafloc- ¼ pt. Lead Ars.- 2 lbs.
5/24	Lead Ars.- 4 lbs. Fermate- .8 lb. Grasselli S.S.- 1 oz.	Lead Ars.- 4 lbs. Summer Oil-3/4 gal. Fermate- .8 lb.	Gesarol AKZ40- 2 lbs. Fesafloc- 1 pt. Fermate- .8 lb.	Gesarol AKZ40- 1 lb. Gesafloc- ½ pt. Fermate- .8 lb.	Gesarol AKZ40- ½ lb. Gesafloc- ¼ pt. Lead Ars.- 2 lbs. Fermate- .8 lb.
6/4	Lead Arsenate- 4 lbs. Fermate- ½ lb. Grasselli S.S.- 1 oz.		Gesarol AKZ40- 2 lbs. Gesafloc- 1 pt. Fermate- ½ lb.	Gesarol AKZ40- 1 lb. Gesafloc- ½ pt. Fermate- ½ lb.	Gesarol AKZ40- ½ lb. Gesafloc- ¼ pt. Lead Ars.- 2 lbs. Fermate- ½ lb.
6/20	"		"	"	"
7/12	"		"	"	"
8/2	"	Lead Ars.- 4 lbs. Summer Oil-3/4 gal. Bl.Leaf 40-3/4 pt. Fermate- ½ lb.	"	"	"

* Work of P. L. Rice, Department of Entomology, Delaware Agricultural Experiment Station.

Comments and Results - Spray Program - Richardson-Kelly Orchard - Red Delicious Variety - Rising Sun, Delaware - 1945

Orchard block, 14 x 23 rows, 18-year-old Red Delicious, planted 40' x 40'; divided into 4 sections, which provided 4 replications (each a 9-tree plot) of 5 treatments; count trees, the center tree of each plot; applications with speed sprayer, as listed elsewhere; dropped fruit examined August 10; red mite counts, August 2 and 9; harvest records, September 6 and 7.

Bait Pan Collections (1325 moths) in relation to Spray Applications

Periods	Days	Number of Moths	Number per Day	Percent of Total	Large Collections during Periods	Number of Sprays
4/14 to 5/7	24	81	3	6	First moths 4/14 4/30-36, 5/1-17	3
5/8 to 5/22	15	685	46	52	5/8-268, 5/13-97, 5/14-82, 5/16-64, 5/22-63	1
5/23 to 6/7	16	84	5	6	5/29-15, 6/1-15	1
6/8 to 6/22	15	258	17	19	6/8-22, 6/12-38, 6/16-43, 6/17-29	2
6/23 to 7/31	39	157	4	12	6/23-12, 6/26-15, 7/18-11, 7/19-13, 7/22-11, 7/29-11	1
8/1 to 8/31	31	60	2	5	8/8-7, 8/25-5, 8/29-5	1

(Procedure set forth in U.S.D.A. - ET-215 followed in sampling fruit)

Points of Comparison and Control of Codling Moth and Red Mite	Plot 1 (Lead-4 lbs.)	Plot 2 (Lead-Oil-Nicotine)	Plot 3 (DDT- .8 lb.)	Plot 4 (DDT- .4 lb.)	Plot 5 (DDT-.2 lb. & Lead- 2 lb.)
Total apples (incl. dropped & harvested fruit)	6,010	7,502	4,610	8,241	7,337
Total apples examined (" " " ")	1,498	1,308	1,439	1,852	1,617
Per cent clean	68	63	85	67	73
Per cent wormy	6	7	5	11	7
Per cent stung	26	30	10	22	20
Extra worms in wormy fruit	125	319	50	437	222
" stings " " "	349	795	87	1,070	437
Total worms	429	811	316	1,468	760
Number of worms per 100 apples	8	11	6	16	9
Total Stings	3,989	5,568	605	4,805	3,246
Number of stings per 100 apples	62	77	13	51	40
Residue on harvested fruit (4 samples of 10 apples each) - grain/lb.	(AS_2O_5) .016	(AS_2O_5) .016	.043	.049	(AS_2O_5) .012
Residue on harvested fruit (4 samples of 10 apples each) - ppm	(AS_2O_5) 2.5	(AS_2O_5) 2.5	6.	7.	(AS_2O_5) 2.
Average number of red mites per leaf	41*	17**	82***	65****	49*

* injury light
** injury very light
*** injury heavy
**** injury rather heavy

GEORGIA

W. H. Clarke, Fruit Pest and Parasite Laboratory, Georgia Department of Entomology, Cornelia.

1. Seasonal Conditions and Status of Codling Moth Infestations for 1945.

A late spring freeze killed the majority of the fruit on all varieties and there was no generally good crop in any one orchard. Spring brood emergence was light and bait traps caught only 351 codling moths during the season.

2. Parasitism of Codling Moth Eggs.

A study of 472 codling moth eggs collected in orchards during June, July and August showed slightly better than 8 percent parasitized by the egg parasite T. minutum. All collections were made in sprayed orchards.

3. Parasitism of Codling Moth Larvae.

Weekly collections of stung apples were brought to the insectary for study of emergence of adult moths and parasites. The only parasite recovered was Ascogaster carpocapsae, and the total parasitism was negligible.

4. Control Experiments using DDT.

The only experiment using poison control was conducted in the orchard owned by Mr. J. P. Fitts, and the experiment was conducted on the Delicious variety. We were unable to get the DDT in time for a full season schedule and consequently the results secured are not conclusive. The preparation used was a 25 percent wettable DDT dust secured from the E. I. DuPont Nemours Co. The material was used in the last five cover sprays.

(a) Spray Schedule: (Amounts per 100 gallons) 1/

4/ 2/45 - 5 qt. LS; 4 lb. lead ars. ..... 1st cover
4/16/45 - 4 lb. ars. lead; 1 gal. oil; 1-6-100 bordeaux.. 2nd cover
5/ 2/45 - 4 lb. ars. lead; 1 gal. oil; 1-6-100 bordeaux.. 3rd cover
5/17/45 - 4 lb. lead ars.; 1 pt. nicotine sulfate; 1 gal. oil; 3/4-6-100 bordeaux ..... 4th cover 1/
6/ 4/45 - 4 lb. lead arsenate; 5 lb. lime ..... 5th cover 1/
6/19/45 - 4 lb. lead arsenate; 1 gal. oil; 1 1/4-6-100 bordeaux ..... 6th cover 1/
7/12/45 - 4 lb. lead arsenate; 1 gal. oil; 1 1/4-6-100 bordeaux ..... 7th cover 1/
7/26/45 - 4 lb. lead arsenate; 1-6-100 bordeaux..... 8th cover 1/

1/ This is the regular schedule applied by the grower for 1945 and the DDT plat was the same excepting that 4 pounds of the 25 percent DDT was substituted for the lead arsenate in the last five sprays.

(b) Harvest Results

Harvest was during the period of August 16 through August 29. Wormy fruits in the DDT plat totaled 8.64 percent as against 22.23 percent in the regular lead arsenate plat; stung fruits totaled 17.87 percent in the DDT plat as against 25.73 percent in the standard plat; fruits showing codling moth injury either as stings or worms totaled 26.51 percent in the DDT plat and 47.96 percent in the standard plat; sound fruit totaled 71.31 percent in the DDT plat as against 50.13 percent in the standard plat. Fruits with multiple stings and worms favored the DDT plat in approximately the same proportions.

(c) Compatibility

The DDT mixed readily with the other ingredients used in the schedule and no injury to fruit or foliage resulted.

(d) Effects of DDT on Aphids, Red Mites and Beneficial Insects

There was a complete absence of ladybeetles and ant lions in the plat sprayed with the DDT. Aphids were only slightly more numerous but were more noticeable on the newer growth than in the standard plat. There was no noticeable difference in the foliage in the DDT plat until after harvest when a noticeable bronzing of the leaves was apparent. Examination showed the bronzing to be caused by a moderately heavy infestation of red mites. These mites did not occur in any other place in the orchard and no bronzing of the leaves was apparent outside the DDT plat.

It is of interest to report that in another orchard some three miles from the test orchard that a red mite infestation equally as severe was noted, and that no DDT had been used in this latter orchard. A red mite infestation has been found in this orchard during the last three seasons.

(e) Adherence of DDT to Fruit and Foliage

The fruit from the DDT plat showed a heavy coating of spray that could not be washed off in the regular acid bath nearly as well as could the spray on fruits from the regular standard spray plats. Adherence of the DDT to the foliage was very good.

(f) Conclusions

The DDT experiment indicates that this material has possibilities in the control of the codling moth but until a test can be conducted through the season its actual value cannot be determined. DDT is compatible with summer oil and bordeaux. It can be expected that DDT will kill beneficial predators and parasites and that a build-up of mites and scale insects might be expected on trees sprayed with the DDT.

ILLINOIS

S. C. Chandler, Illinois Natural History Survey, Carbondale.

CODLING MOTH EXPERIMENTAL WORK IN ILLINOIS, 1945

Experimental work on codling moth in Illinois consisted chiefly of tests with DDT (Dichloro-diphenyl-trichloroethane) in eleven apple orchards in nine counties. In Table 1 the most important data from the spray schedules used in ten of these orchards are given. In this and succeeding tables the orchards and counties are listed from south to north in the state.

In comparing the final infestation data given in Table 2 with the schedules in Table 1, consideration should be given to the total number of sprays applied with each treatment, date of last spray, and other items which might affect the results besides the materials used. In two of these tests the spraying was supervised by us, the others being grower tests watched throughout the season and applied just as a grower would do it in his whole orchard.

Some of the disadvantages of the use of DDT are shown in Table 3, which shows the condition of fruit and foliage in the various plots. The "Oil-DDT" injury began to show after the third or fourth application of DDT with summer oil. A very important test was conducted in the Eckert orchard in a block of several varieties which showed that certain varieties are practically immune to this injury. The susceptibility was found to be as follows:

None to Light	Moderate to Severe	Very Severe
Winesap	Jonathan	Duchess
Stayman	Delicious	Wealthy
York	Golden Delicious	
Maiden Blush	Grimes Golden	
San Jacinto		

The term oil-DDT injury must be broadened to include other highly chlorinated materials, since identical injury was produced by the Z 39 (dichloro-diphenyl-dichloroethane) and by H. E. 761, a related compound whose composition we do not know(Nugent & Schapanski orchard.)

This injury did not occur in the 11th orchard, the Lee Pray orchard in Champaign County (supervised by Dr. M. D. Farrar). Oil was used in only one and two applications and injury was absent. Some of the best appearing fruit and foliage was in the DDT plots. Infestation data are not given in Table 2 because of a wide variation in size of crop and

consequently in infestation. DDT from several different companies was used in this test, and as nearly as we could judge, considering the crop differences, control was not significantly different with these materials.

Conclusions

1. Control of codling moth and leafhopper was always better in DDT than in standard blocks regardless of the fact that in some tests fewer applications of DDT were given.

2. Considerable evidence was obtained to show that DDT with summer oil can be used at less frequent intervals and fewer times than standard materials.

3. The combination of 1/4 pound and 1/2 pound of DDT with half-strength lead arsenate or nicotine was about as good as 1 pound of DDT alone. The lead arsenate-DDT combination was more effective than the nicotine-DDT one.

4. No significant differences in control resulted with the various brands of DDT used.

5. DDT as we used it with summer oil in several applications always caused injury, the injury being somewhat in proportion to the amount of DDT used (less severe in combinations of small amounts DDT with lead or nicotine).

6. Mite injury was moderate to severe in all DDT plots, being less severe with smaller amounts of DDT with lead arsenate or nicotine.

7. In the orchards in which these tests were conducted there were, at harvest, three in which the fruit was greener in the DDT blocks than in the standard, two in which it was smaller, and three in which it was more russeted.

Table 1. Data from Spray Schedules used in DDT Experiments in Illinois, 1945.

Orchard	County	Variety	Plot No.	Total No. Sprays	Date Last Spray	Number of Applications Containing: Lead Ars. Alone	Nicotine Alone	DDT 1 lb. Alone	DDT ½ lb. Lead 2	DDT ½ lb. Lead 2	DDT-Nicotine	Oil With DDT	Bordeaux With DDT	Other Insecticides
Smith	Johnson	Jonathan	1	9	8/18	2	-	7	-	-	-	6	4	-
			2	9	8/18	2	1	-	-	6	-	6	3	-
			3	10	8/24	8	2	-	-	-	-	-	-	-
			4	10	8/24	7	2	-	-	1	-	1	-	-
Sauer	Jackson	Winesap	1	11	8/22	3	-	8	-	-	-	8	7	-
			2	10	8/3	3	-	-	7	-	-	7	7	-
			3	11	8/22	3	8	-	-	-	-	-	-	-
			4	11	8/22	3	-	-	-	-	8	8	-	-
			5	11	8/22	11	-	-	-	-	-	-	-	
Eckert	St. Clair	Jonathan	1	14	8/13	2	12	-	-	-	-	-	-	-
			2	12	7/2	2	3	7	-	-	-	7	-	-
Gage-Hawkins	Jefferson	Jonathan	1	12	8/28	9	3	-	-	-	-	-	-	-
			2	12	8/28	5	-	7	-	-	-	7	4	-
Nugent and Schapanski	Jersey	Jonathan	1	15	8/22	3	12	-	-	-	-	-	-	-
			2	14	8/20	3	-	5	6	-	-	8	6	-
			3	14	8/20	3	-	-	11	-	-	8	10	-
			4	14	8/21	3	-	-	-	-	-	-	-	HE 761 Z 39*
			5	14	8/21	3	-	-	-	-	-	-	-	Z 39*
			6	14	8/21	3	-	-	-	-	11	8	-	-
			7	14	8/21	3	-	5	6	-	-	8	6	-
			8	14	8/21	3	-	-	11	-	-	8	10	-
			9	15	8/25	15	-	-	-	-	-	-	-	-
			10	15	8/25	11	4	-	-	-	-	-	-	-
Ringhausen	Calhoun	Willow Twig	1	8	8/18	8	-	-	-	-	-	-	-	-
			2	8	8/18	2	-	6	-	-	-	6	6	-
Coffman	Pike	Grimes Golden	1	12	8/25	4	8	-	-	-	-	-	-	-
			2	10	8/25	5	-	5	-	-	-	5	-	-

Table 1. Data from Spray Schedules Used in DDT Experiments in Illinois, 1945 (Continued)

Orchard	County	Variety	Plot No.	Total No. Sprays	Date Last Spray	Number of Applications Containing: Lead Ars. Alone	Nico-tine Alone	DDT 1 lb. Alone	DDT ¼ lb. Lead 2	DDT ½ lb. Lead 2	DDT-Nico-tine	Oil With DDT	Bordeaux With DDT	Other Insecti-cides
Veihl	Adams	Jonathan	1	13	8/27	6	7	-	-	-	-	-	-	-
			2	13	8/27	4	-	3	-	6	-	6	-	-
Chatten	Adams	Jonathan	1	8	8/1	8	-	-	-	-	-	-	-	-
			2	8	8/1	4	-	-	-	-	4	3	-	-
Thornton	Adams	Delicious	1	12	8/31	6	6	-	-	-	-	-	-	-
			2	9	8/31	2	-	5	-	-	2	5	-	-
			3	10	8/31	3	1	-	-	4	2	6	2	-

Explanatory notes on above Spray Schedules

Lead Arsenate "Alone" and Nicotine "Alone" and DDT "alone" means with no other insecticides.
Amounts given are for 100 gallons.
DDT expressed in actual DDT.
DuPont's Deenate 25 used in all orchards except as follows:
Smith Orchard, Geigy's DDT in first two sprays.
Nugent & Schapanski Orchard, Geigy's DDT AK 40 used in Plots 7 and 8
Oil used Standard Oil Co. Superla 2 qts. to 100 except that in Ringhausen Orchard, 1 quart of Dendrol used in addition.
*Rohm & Haas HH 761 used in Plot 4 of Nugent & Schapanski Orchard 1½ lbs. to 100 gal. in 5 applications followed by Rohm and Haas Z 39, ½ lb. with Lead 2 to 100 gallons. In Plot 5 Z 39 was used at ½ lb.-100 with Lead 2-100.
The DDT with Nicotine in the Sauer and the Nugent & Schapanski orchard was Tobacco By-Products Co. "Formula X" 7% Nicotine and 17% DDT and was used at 2 lb. per 100 gallons.
The DDT with Nicotine in the Chatten and Thornton orchards was ½ lb. DDT with 2 lbs. B.L. 155.
"Nicotine alone" in practically every spray was B.L. 155 with the exception of the Eckert Orchard in which it was Tank Mixed nicotine bentonite.
A lead-nicotine split schedule in which lead arsenate and nicotine are both used in 1 or 2 applications was used in Plot 10 of Nugent & Schapanski Orchard; Plot 1, Coffman Orchard; and Plot 1, Thornton Orchard.

Table 2. Final Infestation Records on Picked Fruit in DDT Experimental Plots in Illinois, 1945

Orchard	Plot No.	Materials Used Chiefly In Spray Schedule Amounts per 100 gallons	Percent Wormy Apples	Worms per 100 Apples	Percent Stung Apples	Stings per 100 Apples
Smith	1	DDT 1 lb. 1/	1.0		1.6	
	2	DDT 1/2 lb. Lead Arsenate	.4		1.4	
	3	Lead Arsenate	13.0		10.7	
	4	Lead Arsenate, one DDT	16.1		11.5	
Sauer	1	DDT 1 lb.	1.0	1.0	2.8	3.2
	2	DDT 1/4 lb. Lead Ars. 2 lb.	6.6	9.0	5.9	8.7
	3	BL 155	2.4	2.7	3.5	4.7
	4	DDT with nicotine	9.2	11.4	7.9	10.1
	5	Lead Arsenate	4.0	5.1	11.9	16.7
Eckert	1	DDT	0		0	
Duchess	2	Tank mixed nicotine	.4		.7	
Wealthy	1	DDT	.1		.3	
		Nicotine, tank mix	.5		.5	
Jonathan	1	DDT	3.4		2.6	
	2	Nicotine, tank mix	16.4		7.0	
Gage-	1	Lead Arsenate, nicotine	2.2		6.6	
Hawkins	2	DDT 1 lb.	0		.5	
Nugent &	1	BL 155	11.8	18.3	5.3	7.6
Schapanski	2	DDT (Dupont) 1 lb.	2.6	2.7	2.2	2.4
	3	DDT (Dupont) 1/4 lb. Lead 2	2.4	2.5	3.4	5.0
	4	HE 761-late Z39 and Lead	68.3	180.9	11.1	62.5
	5	Z39 1/2 lb. Lead 2	59.7	152.3	10.6	50.3
	6	DDT with nicotine	11.0	15.9	5.4	5.8
	7	DDT (Geigy) 1 lb.	3.6	3.9	4.8	4.8
	8	DDT (Geigy) 1/4 lb. Lead 2	4.8	6.1	3.2	3.5
	9	Lead Arsenate	19.2	29.0	19.5	44.2
	10	Lead Nicotine split	12.8	16.4	18.4	37.5
	Check	None treatment	92.0	247.0	6.0	19.8
Ringhausen	1	Lead Arsenate	2.4		9.5	
	2	DDT 1 lb.	.1		1.4	
Coffman	1	Lead-nicotine split	7.6		14.0	
		DDT 1 lb. from 5th cover	4.0		5.0	
Veihl	1	Lead Arsenate, nicotine	.7		2.0	
	2	DDT 1/2 lb. Lead 2	0		0	
Chatten	1	Lead Arsenate	3.0		12.0	
	2	DDT 1/2 lb. BL 155	0		0	
Thornton	1	Lead Arsenate, nicotine split	45.2		21.8	
	2	DDT 1 lb.	3.6		5.4	
	3	DDT 1/2 lb. Lead 2	7.2		15.0	

1/ DDT amounts given are actual DDT.

Orchard	Plot No.	Materials Used Chiefly In Spray Schedules, Amounts per 100 gallons	Injury from Oil-DDT	Injury from Leaf Hoppers	Injury from Mites	Color, Size, and Quality of Fruit
Smith	1	DDT 1 lb.*	Severe	None	Severe	Green
	2	DDT ½ lb. Lead Ars. 2	Moderate	None	Moderate	Green
	3	Lead Arsenate chiefly	None	Light	None	Normal
	4	Lead Arsenate one DDT	None	Light	None	Normal
Sauer	1	DDT 1 lb.	None	None	Moderate	Green
	2	DDT ¼ lb. Lead 2	None	None	Less than Plot 1	Green
	3	BL 155	None	Light	None	Normal
	4	DDT with nicotine	None	None	Less than 1	Green
	5	Lead Arsenate	None	Light	None	Normal
Eckert	1	DDT 1 lb.	Severe	None	Moderate	Severerusset
	2		(see below)			
	2	Nicotine, tank mix	None	Light	None	Light russet
Gage-Hawkins	1	Lead Arsenate-nicotine	None	Light	None	Normal
	2	DDT 1 lb.	Severe	None	Moderate	Somewhat greener and smaller
			Grade of Injury 1 to 4 (nearly none to severe)			
Nugent & Schapanski	1	BL 155	1	Light	1	Normal
	2	DDT (Dupont) 1 lb.	4	None	4	
	3	DDT (Dupont) ¼ lb. Lead 2	2	"	3	
	4	HE 761 later Z39, Lead	3	"	3	
	5	Z39 ½ lb. Lead 2 lb.	2	"	3	
	6	DDT with nicotine	3	"	2	
	7	DDT (Geigy) 1 lb.	4	"	4	
	8	DDT (Geigy) ¼ lb. Lead 2	2	"	3	
	9	Lead Arsenate	1	Light	1	
	10	Lead-nicotine split	1	"	1	
Ringhausen	1	Lead Arsenate	None	Light	None	Normal
	2	DDT 1 lb.	Moderate	None	Moderate	Normal
Coffman	1	Lead-nicotine split	None	Light	None	Normal
	2	DDT 1 lb. from 5th cover	Light	None	Moderate	Normal

* Amounts DDT are actual DDT

Table 3. Condition of Fruit and Foliage in DDT Experimental Plots in Illinois, 1945 (continued)

Veihl Orchard	Plot No.	Materials Used Chiefly In Spray Schedules, Amounts per 100 gallons	Injury from Oil-DDT	Injury from Leaf hoppers	Injury from Mites	Color, Size, and Quality of Fruit
Veihl	1	Lead Arsenate-nicotine	None	Light	Severe	Normal
	2	DDT ½ lb. Lead 2 lb.	Severe	None	Moderate	Severlly russeted
Chatten	1	Lead Arsenate	None	Light	None	Normal
	2	DDT ½ lb. BL 155	Light	None	Moderate	Normal
Thornton	1	Lead Ars.-nicotine split	None	Light	None	Normal
	2	DDT 1 lb.	Severe	None	Severe	
	3	DDT ½ lb. Lead 2 lb.	Very severe	None	Severe	

ILLINOIS (Continued)

M. D. Farrar, Illinois Natural History Survey, Urbana.

Several brands of DDT were compared with lead arsenate in a semi-commercial test at Savoy, Illinois using unreplicated plots of sufficient size to require 550 gallons of spray under the conditions of this test.

The orchard was sprayed by the owner up to May 4 and as follows thereafter:

Date	Plots Sprayed
May 14	1, 2, 3, 4 - then rained out
June 4, 5	All plots using 2 qt. summer oil per 100 gallons with treatments applied to plots 5, 6, and 14.
June 18, 19	All plots using 2 qt. summer oil per 100 gallons with all treatments.
June 25	All plots using 2 qt. summer oil per 100 gallons with all treatments.
August 2 to 4	All plots; no oil.

The treatments and detailed results on two varieties are given in Tables 1 and 2 while the amount of visible residue, the condition of the foliage and the abundance of the red spider in the several plots is indicated in Table 3.

Table I. Harvest Results
Variety, Grimes Golden; Harvested September 10, 1945

Plot	Treatment	DDT Formulation	No. Fruit Graded	Per 100 Apples		Percent Scab	Crop Load
				Stings	Entrances		
11	1/2# DDT	F	1013	25.0	27.0	48.2	Heavy
1	1# DDT	C	1226	3.4	1.0	67.6	Very heavy
3	1# DDT	B	1078	4.6	2.6	79.0	Very heavy
7	1# DDT	A	1043	20.6	11.0	74.0	Very light
9	1# DDT	E	1125	4.0	0.6	42.0	Very heavy
12	1# DDT	F	1106	9.1	6.9	69.8	Heavy
15	1# DDT	D	1046	10.7	3.4	77.1	Light
	Averages		1104	8.7	4.2	68.2	
13	2# DDT	F	1091	7.9	3.9	47.2	Medium
2	1/4# DDT + 1/2 lead arsenate schedule	C	1081	6.6	3.1	77.0	Very heavy
4	1/4# DDT + 1/2 lead arsenate schedule	B	1099	12.0	4.2	67.7	Very heavy
8	1/4# DDT + 1/2 lead arsenate schedule	A	1115	30.9	10.8	91.0	Very light
10	1/4# DDT + 1/2 lead arsenate schedule	E	1122	5.0	1.5	42.6	Very heavy
16	1/4# DDT + 1/2 lead arsenate schedule	D	969	28.5	13.3	63.5	Light
	Averages		1077	16.6	6.6	56.9	
14	1/4# DDT + 1/2 nicotine bentonite tank mix	D	1123	8.5	7.2	83.5	Medium
5	Formula X		1084	15.1	12.4	59.8	Medium
6	B.L. 155		1108	18.1	18.7	71.4	Medium
17	Standard Lead Arsenate Schedule Average of 2		948	42.7	7.3	48.9	Medium

Table II. Harvest Results
Variety, Golden Delicious; Harvested September 28, 1945

Lot	Treatment	DDT Formulation	No. Fruit Graded	Per 100 Apples Stings	Per 100 Apples Entrances	Percent Scab	Crop Load
11	1/2# DDT	F	414	17.8	27.2	50.2	Heavy
1	1# DDT	C	450	3.5	3.7	34.6	Heavy
3	1# DDT	B	498	3.2	2.6	50.4	Heavy
7	1# DDT	A	--	--	--	--	--
9	1# DDT	E	480	2.4	0.2	61.2	Very heavy
12	1# DDT	F	525	10.7	8.8	58.4	Light
15	1# DDT	D	--	--	--	--	Light
	Averages		488	4.9	3.8	51.1	
13	2# DDT	F	--	--	--	--	--
2	1/4# DDT + 1/2 LA[1] schedule	C	466	7.3	4.2	38.4	Very heavy
4	1/4# DDT + 1/2 LA schedule	B	350	26.0	14.6	57.7	Very heavy
8	1/4# DDT + 1/2 LA schedule	A	--	--	--	--	--
10	1/4# DDT + 1/2 LA schedule	E	380	7.1	8.6	93.4	Very heavy
16	1/4# DDT + 1/2 LA schedule	D	--	--	--	--	--
	Averages		399	13.5	9.1	63.2	
14	1/4# DDT + 1/2 Nicotine Bentonite tank mix	D	--	--	--	--	
5	Formula X		400	17.2	15.3	37.0	Medium
6	B.L. 155		--	--	--	--	--
17	Standard Lead Arsenate Schedule Average of 3		422	46.8	11.8	65.1	Medium

1/ LA = Lead Arsenate

Table III. Condition of Orchard, October 10, 1945 As Graded By M. D. Farrar and S. C. Chandler

Plot	Treatment	Visible Residue	Condition of Foliage 5= Excellent	Abundance of Red Spider 5= Heavy
11	1/2# DDT (F) 1/	None	5	5
1	1# DDT (C)	None	4	5
3	1# DDT (B)	None	3	5
7	1# DDT (A)	None	5	5
9	1# DDT (E)	Heavy	4	5
12	1# DDT (F)	None	5	5
15	1# DDT (D)	None	5	5
13	2# DDT (F)	None	4	5
2	1/4# DDT (C) + 1/2 Lead Ars. Schedule	Moderate	2	4
4	1/4# DDT (B) + 1/2 Lead Ars. Schedule	Moderate	2	0
8	1/4# DDT (A) + 1/2 Lead Ars. Schedule	Moderate	2	1
10	1/4# DDT (E) + 1/2 Lead Ars. Schedule	Heavy	2	1
16	1/4# DDT (D) + 1/2 Lead Ars. Schedule	Moderate	3	4
14	1/4# DDT (D) + 1/2 Nicotine-Bentonite Tank Mix	None	5	0
5	Formula X	None	5	4
6	BL 155	None	5	0
17	Standard Lead Arsenate Schedule	Heavy	2	0

1/ Letter in parenthesis refers to formulation.

Results secured indicated the general superiority over other treatments tested of the program in which DDT was used at the rate of 1 pound per 100 gallons in the regular spray schedule. Where 1/4 pound of DDT was used with 1/2 the usual quantity of lead arsenate control was not as good as obtained with the 1 pound of DDT but was equal or superior to that obtained with lead arsenate at the usual strength. This test involved a comparison of DDT formulations produced by six manufacturers. All seemed to perform satisfactorily.

INDIANA

G. Edward Marshall, Indiana Agricultural Experiment Station, Orleans.

The codling moth control plots at the Elrod Orchard in 1945 received practically the same spray materials as in 1943 and 1944. This was done in order to provide answers to specific questions asked by Indiana growers. The treatments used have been proven to be the best we know of at the present time. Each of the four schedules is a treatment which if diligently and thoroughly applied and if fortified by good sanitational practices, bait trap data for timing sprays and a few extra sprays on years during which the codling moth is especially bad, will control the insect to the point where the wormy fruits will be held to 15 percent or less and will do so with a minimum of foliage injury. Table 1 provides most of the detailed information as to the program followed and the number of sprays applied in 1945 and gives the measure of control attained.

Detailed costs and estimated returns of the above program have been recorded in previous reports. Again in 1945, as in 1943 and 1944, treatment 2 was the most expensive when all factors were considered.

Table 1. Spray Schedule and infestation Counts - Elrod Orchard, 1945.

Plot	Cover 1/ Sprays	Materials 2/ (Amounts per 100 gallons)	Date of Sprays	Worms per 100 Apples	Per-cent Clean	Bushels per Tree
1	4	3# BL 155, 1/2 gal. MO	June 25			
	5	5# WB, 1 pt. N. 1 qt. SO	June 27			
	6-7	7# MB, 1 pt. N. 1 qt. MO	July 12-13			
			July 25-26	46.50	57.50	19.22
	8	5# WB, 1 pt. N. 1 qt. SO	Aug. 8			
	9	7# MB, 1 pt. N. 1 qt. SO	Aug. 20			
	10	8# MB, 1 pt. N. 1 qt. SO	Aug. 30			
2	4	3# LA, 1# L, 1# $ZNSO_4$	June 17			
		1/2 gal. MO	June 22			
	5-6	3# LA, 1# L, 1# $ZNSO_4$	June 21-22			
		1/2 gal. MO	July 22	60.25	36.00	19.25
	7	3# LA, 1# L, 1/2 gal. MO	July 16-17			
	8	3# LA, 3# L, 1/2 gal. MO	July 31			
	9	3# LA, 2# L, 2# $ZNSO_4$ 1/2 gal. MO	Aug. 8-10			
3	4	3# BL 155, 1/2 gal. MO	June 23-25			
	5-6	3# BL 155	July 3-4, 12-13			
	7	3# BL 155, 1/2 gal. MO	July 24-26			
	8	3# BL 155	Aug. 2-3	14.75	70.00	22.86
	9	3# BL 155, 1/2 gal. MO	July 10-12			
	10-11	3# BL 155	Aug. 20,30			
4	4-5	4# LA, 1/2 gal. MO, 5 oz. S	June 27 July 2-3, 14-16			
	6 (Top-off only)	4# LA, 5 oz. S 1/2 gal. MO	July 30	23.25	46.25	22.75
	7	8# WB, 1 pt. N, 1# 13oz. S 1/2 gal. SO	Aug. 14 Aug. 15-16			

1/ Entire orchard received eight sprays containing materials for apple scab control, between the delayed dormant period and June 16, the date of the beginning of the first cover spray. Lead arsenate at the rate of three pounds per 100 gallons of water with lime was used for codling moth control in the first three covers of plots two and four. Lime was left out or reduced in the first three cover applications of plots one and three. Plot one received zinc sulfate as a safener in the first three covers.

2/ Liquid lime sulfur used through the calyx with three pounds of lead arsenate in the calyx application.

MS - Micronized sulfur
F - Fermate
LA - Lead Arsenate
MB - Mississippi Bentonite
MO - Mineral Oil (302 Gulf & Spuria 15)
N - Black Leaf 40

BL 155 - Black Leaf 155
$ZNSO_4$ - Zinc Sulfate
SO - Soybean Oil
S - Soap
WB - Wyoming Bentonite
ALSO - Aluminum Sulfate
L - Lime

IOWA

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Purpose of Experiments: Series 1. To test the efficiency of a 1 pound dosage of DDT in comparison with lead arsenate when applied well into the 2nd brood period, and followed by lighter dosages as harvest approaches; series 2, to test the ability of several light applications of DDT to halt the increase of a codling moth population in lead arsenate sprayed trees after it is well established.

Location: In a large commercial orchard at Mitchellville, Iowa. Apple varieties: Red Delicious, Golden Delicious, Jonathan, Ben Davis, and Northwestern Greening, principally.

Methods: Randomized experimental rows (mostly of 45 trees each) separated by single barrier rows which were sprayed with the standard lead arsenate mixtures. Six count trees were located at random in each row. Fifty apples examined at random in each count tree without removing fruit from the tree. Sampling was done at intervals throughout the season. Criteria of effect: (1) Percentage of infested apples (apples with stings, worms and/or other blemishes per 100 apples); (2) Blemishes (stings, worms, etc.) in 100 apples.

Results: Given in Tables 1 and 2.

Comments: The 1-pound dosage of DDT gave excellent results so long as it was maintained. A sharp percentage increase occurred when lower dosages followed the 1 pound applications. Dosages of DDT as low as 0.25 to 0.33 pound did not halt the increase of an established codling moth infestation.

DDT appeared to injure the foliage of Northwestern Greening trees; the effect was a bronzing of the foliage which occurred late in the season. No mites or evidences of mite activity were found on these trees.

Comparison of codling moth infestation in 1945 with infestations in the same orchard in 1939 to 1942 indicates that the 1945 infestation was of moderate degree.

The apple aphid (Aphis pomi Deg.) was present until mid July, but was not more abundant in the DDT plots than in the lead arsenate plots.

Leafhoppers and mites were scarce throughout the season.

Table 1. Comparative Tests with DDT and Lead Arsenate in Sprays for Codling Moth Control (Series I).

	Dates of		DDT Sprays			Standard Lead Arsenate Sprays		
	Application	Record	Ingredients per 100 gallons	Percent Apples Infested	Blemishes per 100 Apples	Ingredients per 100 gallons	Percent Apples Infested	Blemishes per 100 Apples
Pre-blossom	April 2-17	None	1.5 gal. Lime-Sulfur	--	--	1.5 gal. Lime-Sulfur	--	--
Calyx	May 2-11	May 11	3 lb. Lead arsenate 6.25 lb. W. sulfur 3 lb. Lime	None	None	3 lb. Lead arsenate 6.25 lb. W. sulfur 3 lb. Lime	None	None
1st Cover	June 1-2	May 31	1 lb. DDT 1/ 1 lb. Fungicide 2/	None	None	4 lb. Lead arsenate 6.25 lb. W. sulfur 3 lb. Lime	None	None
2nd Cover	June 11-12	June 12	1 lb. DDT 1 lb. Fungicide 2/	0.2	--	4 lb. Lead arsenate 1 lb. Fungicide 2/	0.5	--
3rd Cover	June 20-21	June 21	1 lb. DDT 0.75 lb. Fungicide 2/	0	0	4 lb. Lead arsenate 0.75 lb. Fungicide 2/ 0.8 gal. Oil	1.3	--
4th Cover	June 29	July 3	1 lb. DDT	0	0	4 lb. Lead arsenate 1 lb. ZNSO4, 1 lb. Lime 0.8 gal. Oil	4.3	--
5th Cover	July 18-20	July 19	1 lb. DDT 0.56 lb. Fungicide 2/	0.2	--	4 lb. Lead arsenate 0.56 lb. Fungicide 2/ 0.8 gal. Oil	10.8	15.2
6th Cover	Aug. 7	Aug. 10	0.75 lb. DDT	0.6	--	4 lb. Lead arsenate	13.9	20.9
7th Cover	Aug. 24-30	Aug. 28	0.33 lb. DDT 3 lb. Lead arsenate	3.7	3.8	0.33 lb. DDT	27.7	52.0
--	--	Sept. 20	--	7.6	8.6	--	35.8	67.2

1/ All DDT dosages represent actual weight of DDT. Preparation was Geigy's AK-40 (40% DDT).

2/ Ferric dimethyl+dithio+carbamate (Fermate).

Table 2. Tests with Light Applications of DDT following Lead Arsenate Sprays for Codling Moth Control (Series II).

Spray	Dates of Application	Dates of Record	DDT - Lead Arsenate Schedule: Ingredients per 100 gallons	Percent Apples Infested	Blemishes per 100 Apples
Calyx, 1st, 2nd, 3rd, & 4th Covers	May 2 to June 29	Not Recorded	Same as Standard Lead arsenate sprays (Table 1)	--	--
5th Cover	July 17	July 26	0.25 lb. DDT 1/ 4 lb. Lead arsenate 0.56 lb. Fungicide 2/	10.8	15.9
6th Cover	Aug. 3	Sept. 7	0.25 lb. DDT 3 lb. Lead arsenate	27.2	41.2
7th Cover	Aug. 25	Sept. 24	0.33 lb. DDT	31.5	52.8

1/ Actual DDT (Geigy's AK-40).
2/ Ferric dimethyl-dithio-carbamate (Fermate).

KANSAS

R. L. Parker and E. L. Eshbaugh, Kansas Agricultural Experiment Station, Manhattan

Introduction

During the season of 1945 the entomological staff of the northeastern Kansas Experiment Fields continued comparative tests of certain insecticide combinations as substitutes for lead arsenate in spraying for the control of codling moth. The tests were conducted at the Blair experiment orchard of the northeastern Kansas Experiment Fields. The apple variety used for the tests was Jonathan. Standard dosage of lead arsenate; lead arsenate plus zinc sulfate plus summer oil emulsion; "Gesarol AK40 Spray" 1/ (40% DDT - Dichloro-diphenyl-trichloroethane); fixed nicotine, "Black Leaf 155" 2/, plus summer oil emulsion; and "Black Leaf 155" - DDT (17%) mixture 2/ plus summer oil emulsion were compared.

1/ Furnished by the Geigy Company, Inc., New York, and in cooperation with the Crop Protection Institute.

2/ Supplied by the Tobacco By-Products Corporation, Louisville, Ky.

Methods and Procedure

Two single tree replicates were used for each insecticide or combination of insecticides tested. To obtain as near uniform conditions as possible, the replicates were randomized in four rows of trees containing ten trees to each row. Two early sulfur sprays were applied to the plots for scab control. Lead arsenate at the rate of 4 pounds to 100 gallons of water was applied uniformly to all trees in all plots in the calyx spray.

Zinc sulfate in combination with lead arsenate and summer oil emulsion was tested during the season of 1945 for codling moth control and as a safener for lead arsenate when used on Jonathan foliage. Lead arsenate alone (without any safener) was used on one series of tree replicates. Summer oil emulsion was left out of the sprays used on the zinc sulfate-lead arsenate plots after the fifth cover spray. The amount of summer oil emulsion was reduced for the second brood sprays in all plots, except in the lead arsenate - "Black Leaf 155" schedule, where this material was used in combination with the fixed nicotine.

The purpose of the DDT tests was to determine how this material would compare to lead arsenate and fixed nicotine combination as a control for codling moth and whether the common red spider and the apple leafhopper would be controlled.

As a protection to the test plots, lead arsenate-zinc sulfate-summer oil emulsion spray applications were applied to all trees surrounding the replicates on the same day as the trees under test were sprayed. Eight cover sprays were applied to all spray plots.

To prevent premature excessive drop of fruit, one hormone spray application of napthalene acetic acid was applied September 1 to trees in the spray plots.

Dropped apples were picked up at intervals during the summer, counted and scored for worms and stings. The preharvest dropped apples to the number of 400 per tree were collected and recorded September 6 and 7. A harvest count of up to 500 fruits per tree was made September 13.

Seasonal Conditions and Codling Moth Abundance

First Brood. The first moths from the overwintering generation of larvae were caught in bait traps May 14. Following emergence cool, rainy weather delayed the developmental progress of the codling moth during the interval between May 14 and May 24. The first worm entries were noted May 31. May 28 to June 2 was an interval of large moth catches. The heaviest hatch of worms occurred from June 9 to June 15. By June 4, catches of overwintering brood moths in bait traps began to diminish. Variable weather conditions resulted in a prolonged and slow emergence of first brood moths.

Second Brood. Bait trap catches and emergence cages on July 13 indicated that the first brood moths were emerging. Emergence of these moths was characterized by a steady bait trap catch with few highs and lows of numbers of moths caught. There were no outstanding peak catches; only alternating high and low catches closely associated with weather conditions. Damage from second brood worms was steady throughout the interval from July 20 to August 15. Codling moth activity increased August 13 to September 1 during a period of warm favorable weather resulting in higher moth catches and a large hatch of late second brood worms. The operation of the bait traps was discontinued September 1. The most severe damage of the season was from late second brood worms.

Third Brood. As far as it was possible to determine, there was no third brood of worms. Worms found late in the season probably were from a prolonged second brood moth emergence.

Seasonal Damage

The codling moth season of 1945 was characterized by a light, easily controlled first brood, the activity of which was held down by unfavorable weather. Favorable weather conditions for development of the codling moth the last half of the second brood, August 13 to September 1, along with a light set of fruit resulted in the heaviest worm damage of the season.

Due to cool nights, plentiful rains and irregular weather conditions, bait trap catches, in terms of numbers caught, were not a reliable index of codling moth activity and damage to be expected during the season of 1945.

The last three sprays of the season of 1945 were the more important sprays for protecting the crop from the large hatch of late worms. Even when the control of the first brood worms appears to have been successful, severe damage to fruit can result from late season worms.

The combinations of insecticides used in 1945 are indicated in Table I.

Table I. Insecticides, dosages, and schedules used in control tests in pounds per 100 gallons of spray mixture.

Treatment: All plots had a calyx spray of lead arsenate, 4 pounds.

1. Lead arsenate, 4 lb.

2. Lead arsenate, 4 lb. plus zinc sulfate, 4 oz. plus Superla oil emulsion, 1 qt. Oil left out after 5th cover spray.

3. Gesarol AK40 Spray (40% DDT) (Dichloro-diphenyl-trichloroethane), 1 lb.

4. Black Leaf 155 - DDT mixture (7% of 100% nicotine and 17% DDT) plus Superla oil emulsion schedule of sprays.
First cover, B.L. 155-DDT, 3 lb.; 2nd through 5th covers, B.L. 155-DDT, 2 lb. plus oil, 2 qt. (1st brood); 6th through 8th covers, B.L. 155-DDT, 2 lb. plus oil, 1 1/2 qt.

5. Lead arsenate, 4 lb. plus zinc sulfate, 4 oz. plus Superla oil emulsion, 1 qt. through first 4 cover sprays (1st brood); Black Leaf 155, 2 lb. plus Superla oil emulsion, 2 qt., 5th through 8th cover sprays (2nd brood).

6. Black Leaf 155 plus Superla oil emulsion schedule of sprays.
First cover, B.L. 155, 3 lb.; 2nd through 5th covers, B.L. 155, 2 lb. plus oil, 2 qt. (1st brood); 6th through 8th covers, B.L. 155, 2 lb. plus oil, 1 1/2 qt.

The spray dates for the season of 1945 were as follows: Calyx, April 30; first cover, May 29; second cover, June 8; third cover, June 21; fourth cover, July 2; fifth cover, July 18; sixth cover, July 30; seventh cover, August 14; eighth cover, August 28. The second cover spray was reapplied to the plots June 14 following hail and heavy rains June 8 and 9.

At harvest time samples of apples from all plots were collected and analyzed for arsenic or DDT residue.

Results

In recording data of injured fruits, multiple stings or worms in any one fruit were not separately considered. When a fruit had both worms and stings it was counted as "wormy".

Foliage on all plots was examined on August 8. The foliage on trees sprayed with lead arsenate without a safener showed marked injury. Most of the leaves had dropped from one of the trees except at the tips of new terminal growth. The other tree showed less injury. Some new leaf growth had started on both trees. The foliage on trees sprayed with fixed nicotine, "Black Leaf 155", combinations showed some yellow leaves. On September 13 defoliation was apparent on all replicates included in the tests except the lead arsenate-zinc sulfate and the "Black Leaf 155" - DDT mixture sprays. Trees of the DDT (Gesarol AK40) plot on August 8 showed a slight copper color of foliage due to a medium heavy outbreak of common red spider mite. By September 13 foliage on the DDT (Gesarol AK40) plots had a distinct copper color. The two trees sprayed with DDT were the only trees in the plots under test showing damage by common red spider mite. Trees in the spray plots showed little leafhopper injury August 8. The injury noted was on leaves of branches touching the ground. A small amount of leaf injury was noted on trees sprayed with DDT but no leafhoppers were found.

The preharvest drop began September 2 to 4. There was a marked tendency for the fruit on the plots treated with lead arsenate alone and on the DDT plots to drop first. By September 5 there was a heavy fruit drop in all test plots. A hormone spray applied September 1 failed to hold the fruit on the trees of all plots. By September 11, a total of 57 bushels of apples had dropped under the twelve trees used in the codling moth tests.

Data for the various insecticide tests for the control of codling moth in the Blair experiment orchard at Blair, Kansas is recorded in the following table:

Table II. Percentages of wormy and stung apples during various periods and the entire season, and residue analyses.

Treatment number	Apples dropped to August 20			Preharvest drops September 6			Harvest counts		Summary (entire season)				Residue (grains As_2O_3 per lb.)[4]		Residue (grains DDT per lb.)[4]
	Total per plot	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Per cent wormy	Per cent stung	Total per plot	Per cent wormy	Per cent stung	Per cent clean	unwashed	washed	unwashed
1.	395	6.33	4.81	800	10.50	18.75	6.20	7.40	2195	7.79	11.07	81.14	0.047	0.011	-----
2.	195	3.59	1.02	558	10.04	12.36	3.01	2.87	1484	5.73	6.20	88.07	0.160	0.018	-----
3.	299	20.07	0.67	776	19.46	3.48	4.60	2.00	2075	12.39	2.36	85.25	0.016	0.002	0.051
4.	196	3.06	0.0	800	4.62	0.75	1.50	0.60	1996	2.91	0.60	96.49	0.007	0.002	0.026
5.	249	8.84	3.21	560	10.36	7.14	5.20	3.10	1809	7.30	4.37	88.33	0.027	0.009	-----
6.	256	2.73	0.78	670	8.96	1.49	4.03	0.75	1721	5.75	1.05	93.20	0.027	0.005	-----

[4]Residue analyses were made by Dr. A. T. Perkins, Department of Chemistry, Kansas Agricultural Experiment Station.

Residue analyses of DDT by the Gunther hydrolysis method.

Summary

The trees in the plot sprayed with "Black Leaf 155" - DDT mixture and summer oil emulsion gave the most effective control, 96.49 percent clean fruit per plot for the season.

The trees in the plot sprayed with "Black Leaf 155" and summer oil emulsion, for the third season, gave effective control, 93.20 percent for the season. This plot had the fourth highest percentage of wormy apples of the six insecticide combinations used.

Trees in the plot sprayed with lead arsenate-zinc sulfate-summer oil emulsion to control the first brood larvae; and with "Black Leaf 155" - summer oil emulsion combination for the control of second brood larvae was third in effective control with 88.7 percent clean fruit.

The trees in the plot sprayed with lead arsenate-zinc sulfate-summer oil emulsion, with oil left out after the fifth cover spray, ranked fourth in effective control, 88.33 percent for the season. This spray combination ranked second in highest percent of apples stung.

Trees in the plot sprayed with "Gesarol AK40 Spray", DDT, had the next to lowest effective control, 85.25 percent clean apples. This plot had the highest percentage of wormy apples of all plots and ranked fourth in percentage of stings. DDT proved more effective in reducing stings but was not effective in reducing worm injury.

The trees in the plot treated with lead arsenate without safener plot had the lowest effective control, 81.14 percent clean fruit. This plot had next to the highest percent of wormy apples of all plots and the highest percent of stung fruit of all test plots.

During late July, through August and into September the common red spider mite population on trees in the "Gesarol AK40 Spray," DDT, plot built up to medium heavy outbreak numbers. No common red spider mite infestation developed in other spray plots.

Zinc sulfate proved to be an effective safener for lead arsenate. The foliage on the trees where this chemical was used was in excellent condition at harvest time. Foliage on the "Black Leaf 155" - DDT mixture plots was in good condition at harvest time. At this time most of the foliage had fallen from the trees sprayed with lead arsenate without safener.

One application of naphthalene acetic acid, a hormone spray, failed to prevent premature dropping of apples near the time of harvest.

The samples of harvest apples which had been sprayed with "Gesarol AK40 Spray", DDT, when analyzed for this chemical, had a residue of 0.051 grain of DDT per pound of apples which is 0.002 grain more than the unofficial residue tolerance. The residue of DDT at harvest on the "Black Leaf 155" - DDT-oil combination was below the unofficial residue tolerance, namely, a residue of 0.026 grain per pound of apples. The analysis was by the Gunther hydrolysis method.

The apple samples from all plots after acid washing were below the arsenic tolerance of 0.02 grain per pound of apples.

KENTUCKY

W. A. Price, W. D. Armstrong, and P. O. Ritcher, Kentucky Agricultural Experiment Station, Lexington.

Seasonal conditions and codling moth abundance. Carry-over of codling moth worms from 1944 was heavy while winter mortality was light. Abnormally warm weather in March caused unusually early pupation and warm weather in early April caused considerable emergence of moths especially in western Kentucky. Cool weather the latter part of April and first half of May was unfavorable for egg-laying and greatly prolonged the moth emergence period. Moth emergence, egg-laying and worm hatch were heavy during the last half of May. As a result the main part of the first brood was late causing Yellow Transparents to be unusually wormy.

Lateness of the worst first brood attack meant extra first brood cover sprays were needed this season, sprays which most growers omitted. Because of continued cool weather, second brood emergence was also late, not becoming heavy until late July. Hot, dry weather during late July, August and early September was very favorable for codling moth and the effectiveness of arsenical deposits was reduced. As a result, in western Kentucky, the only fairly clean crops were in young orchards or in old orchards where effective spraying was continued up to September 1.

Even eastern Kentucky growers, where codling moth is not ordinarily much of a problem, had more worms than usual. In eastern Kentucky it was found that most of the trouble was from late second brood worms, with little indication of much third brood.

Orchard Test with DDT

An experiment was set up in the Park Orchard of the Kentucky Cardinal Farms at Henderson, Kentucky to see if a severe codling moth infestation could be controlled under commercial conditions by fortifying the regular lead arsenate-nicotine and oil spray program with small

amounts of DDT. A block of 27 trees in one corner of the orchard was used as a check plot since the use of a stationary spray plant made adequate replication of plots impractical. This block received the same schedule minus the DDT. Materials used and times of application are given in Table I.

Table I. Results of codling moth spray experiment at Kentucky Cardinal Park Orchard, Henderson, 1945.

Program	Variety	% Wormy Apples	% Stung Apples	Injuries per 100 Apples	
				Worms	Stings
Lead arsenate-fixed nicotine 1/	Grimes	15.0	25.0	17.0	35.0
As above + DDT 2/	Grimes	13.0	19.0	15.0	24.0
Lead arsenate-fixed nicotine	Turley	7.8	17.0	9.6	27.2
As above + DDT	Turley	.5	6.3	.5	7.5
Lead arsenate-fixed nicotine	G. Delicious	5.2	15.2	6.8	19.8
As above + DDT	G. Delicious	.8	5.7	.8	6.6
As above	Stayman	5.0	12.0		

1/ C1, 4/18-LA 4#, L 4#, 1-1 Bordo (Bordo omitted on G. Delicious). C2, 4/30-LA 4#, 1-2 Bordo. C3, 5/14-LA 4#, 1-1 Bordo, SO 2 qt. Top off, 5/18-same. C4, 5/23-LA 2#, 1-2 Bordo, SO 2 qt. 6/13-BL 155 2#, SO 2 qt. C6, 6/23-BL 155 3#, SO 2 qt. C7, 7/10-same. C8, 7/26-same. C9, 8/31-BL 155 3#, SO 1 gal.

2/ As above except C2-4+DDT 6 oz., C5-6 +DDT 8 oz., C7 +DDT 8 oz., C9 +DDT 13 oz.

Results. The DDT and the check areas were virtually free of worms during most of the summer while a large, poorly sprayed block one-half mile south was heavily infested. Late in August many small worms began entering both the lead arsenate-nicotine plot and the DDT area necessitating another spray (C9) applied August 29 to September 1 which stopped late worm attack. Harvest counts made by W. D. Armstrong, (Table I) indicated that good codling moth control was secured in both areas with better control resulting where DDT was added to the regular schedule. A break-down of figures on codling moth injury showed that much of the wormy fruit came from the upper portions of the trees (Table II).

Table II. Distribution of codling moth injury in DDT spray experiment.

Part of Tree	DDT Schedule		Non-DDT Schedule	
	Wormy Apples	Stung Apples	Wormy Apples	Stung Apples
	%	%	%	%
Top	8.7	16.0	19.0	17.4
Middle	4.6	9.4	7.6	15.3
Bottom	.3	6.0	3.2	19.2

There was a small amount of foliage and fruit russeting in the DDT-sprayed area and a few European red mites were found in the calyx ends of a number of fruits. These caused no real injury and the orchard produced the finest crop of sound apples since it came into production. In previous years it had not been uncommon to find 30 or 40 worms and stings in a single apple.

MASSACHUSETTS

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Extremely high temperatures in March advanced plant growth so rapidly that by April bud development in the orchards was approximately a month ahead of normal.

In April, temperatures reverted to ranges more nearly normal for March, with disastrous results to fruit buds. There were several instances when the temperature dropped close to the danger point, and a freeze which caused very general and severe damage occurred on the 23rd. Practically all blossoms were killed and many unopened buds were damaged. In many orchards temperatures dropped to the low twenties. Continued cold following the freeze furnished conditions unfavorable to bee activity and to bud development.

The set of fruit which finally developed was very light and scattering so that many readjustments became necessary in planning the experiments. Further complications arose from the severe hail in mid-June which knocked off some of the young fruit and badly scarred most of the remainder. In the face of such handicaps the results of the season's work could not be given as much weight as could be desired, but some significant differences were secured. Results were based on the record of the McIntosh variety.

Table I

Treatment	Percentage of Fruit Showing Codling Moth Damage
Standard Spray Schedule	10.48
Standard Schedule + Emergency Spray between 2nd and 3rd Cover	1.09
Standard Schedule + Emergency Spray + Fixed nicotine in early August	.97

On unsprayed trees the severe attack of all insect pests and unusual severity of scab caused what fruit survived the early freeze and subsequent hail to drop by early August. Practically all of this was infested by scab, curculio, and codling moth.

In a separate block of McIntosh, different dosages of DDT were employed, in 5 applications (May 15 to July 25) following the calyx. The regular schedule was followed up to and including calyx. Part of this block received the full standard schedule throughout the season to serve as a basis for comparison.

The record of fruit at harvest showed the following results:

Schedule	Percentage of Fruit Showing Codling Moth Damage
Standard Schedule throughout season	3
Lead arsenate 2 lb., DDT (AK-40) 1/2 lb.	6.2
DDT (AK-40) 1 lb.	1.5
DDT (AK-40) 2 lb.	0

In the standard schedule lead arsenate was used in combination with wettable sulfur and lime. The DDT was also combined with wettable sulfur without the addition of excess lime.

Owing to the small crop which developed in this orchard, the total yield was scored. In the plots receiving the lead arsenate-DDT combination the total number of apples was very small so that the few specimens showing codling moth damage caused a higher percentage of loss than would have been the case in an amount of fruit proportional to the other lots. This represents one of the handicaps encountered in such a season as 1945.

MICHIGAN

Herman King, Michigan State College Extension Service, East Lansing.

DDT was used in grower-demonstrations scattered over our entire apple growing area. The formulation used was the wettable powder. Some growers used it alone, some used it in combination with lead arsenate, and a few used a blend of DDT and Black Leaf 155. Where DDT was used alone it was used at the rate of 3/4 pound actual DDT per 100 gallons. Results varied from good to remarkable. No unsatisfactory results were observed. DDT was compatible with the common fungicides. No DDT-oil combinations were used and no injury was observed. Foliage was improved in color, size, and shape. Much of this improvement was the result of leafhopper control. The fruit also showed improvement in color and finish. Repeated sprays of DDT appeared to prevent aphids from becoming troublesome. Analyses indicated that excessive residues were not likely to occur (on late varieties) unless DDT sprays were continued after the first of August.

A build-up of mites was observed in some orchards, but not in others. Weather conditions were unfavorable for mite build-up, however.

MISSOURI

Lee Jenkins, Missouri Agricultural Experiment Station, Columbia.

INTRODUCTION

1945 was a backward season for codling moth development in Missouri with the result that there was very little codling moth damage to apples before the first part of July. The major portion of codling moth damage came during July and August.

METHODS OF PROCEDURE

Four large scale tests of DDT were laid out in Missouri in cooperation with the U. S. D. A. Bureau of Entomology and Plant Quarantine. Two of these plats are reported on in this article. Results in the other two were similar.

Twenty-three small scale plats, where a number of materials were used in comparison with DDT and in combination with DDT, were sprayed. Small scale plats were checked at the University Orchard in cooperation with Professor H. G. Swartwout of the Department of Horticulture, University of Missouri.

Large scale spray plats in cooperation with the U. S. D. A. Bureau of Entomology and Plant Quarantine.

G. E. Jackson Orchard, Marionville, Missouri - Jonathan Variety

Treatment	% Clean	% Wormy	% Stung
10 cover sprays (4 lead and summer oil, 1 lead, and 5 of 1/2 gallon nicosol and 1 1/2 pounds Black Leaf 155)	85.1	9.27	4.58
10 covers of 1 pound actual DDT--100 gallons	97.4	.08	2.47

Bain Gardner Orchard, McBaine, Missouri

11 covers	6 covers of lead arsenate and 5 covers 2 pounds Black Leaf 155 and 1/2 gallon oil--100 gallons	62	32.5	5.3
11 covers	1 pound actual DDT in all covers	95.8	2.7	1.4

The use of DDT in amounts as low as 4 ounces of actual DDT in 100 gallons of water in combination with 2 pounds of lead arsenate permitted a noticeable increase in red spiders.

DDT in combination with Fermate and with Methasan appeared to be as effective in codling moth control as DDT alone. (In cooperation with Professor H. G. Swartwout.)

Large scale plats of DDT gave better control of codling moths than where single trees were sprayed with DDT in an area where less effective materials were used on trees around DDT.

SMALL SPRAY PLATS AT THE BAIN ORCHARD 1945

Jonathan

All plots sprayed with 3 pounds lead arsenate and 6 1/4 pounds dry lime sulfur in calyx and 3 pounds lead arsenate plus 6 pounds mike sulfur in first cover. Calyx applied April 12 and first cover April 25.

Plat 1 - 3 trees. Second cover May 8, 3 pounds lead arsenate plus 4 pounds mike sulfur. Third cover May 22, 4 pounds lead arsenate and 4 pounds mike sulfur with 1-1-100 zinc lime added. Fourth cover June 5, same as third cover. Fifth cover June 14, same as fourth except sulfur was omitted. Sixth cover June 27, 2 pounds 155 plus 1 pint of oil. Seventh cover July 17, same as sixth. Eighth cover August 1, same as sixth cover. Ninth cover August 14-15 - All plats in this block sprayed on the above schedule with the same fungicides except Plat 20.

Plats 2, 3, 4, 5, 6, 7, 8, 13, 16, and 21 sprayed the same as Plat 1 up to and including fifth cover. Plats 14 and 15 are the same as Plat 1 up to the fifth cover, except Safe-N-lead was used instead of zinc lime.

Plat 2 - Same as plot 1 except 1 quart of oil used instead of 1 pint.

Plat 3 - Same as plot 1 except 2 quarts of oil used instead of 1 pint.

Plat 4 - Three pounds of 155 used in sixth and seventh, eighth and ninth covers.

Plat 5 - Sixth cover, tank mix nicotine Bentonite using 8 pounds Mississippi Bentonite, 1 pint nicotine sulfate and 2 quarts of oil. Seventh cover nicotine 3/4 pint. In eighth and ninth covers 4 pounds Bentonite, 3/4 pint nicotine and 1/2 gallon of summer oil.

Plat 6 - Starting with the sixth cover 2 pounds of Black Leaf 155, 1/2 gallon of summer oil and 4 ounces DDT were used in sixth, seventh, eighth, and ninth covers.

Plat 7 - Starting with sixth cover, 8 pounds P. C. Bentonite impregnated with 4 ounces DDT plus 3/4 pint of nicotine sulfate plus 1/2 gallon summer oil in sixth, seventh, eighth, and ninth covers.

Plat 8 - Same as plat 1 through 5th cover. Sixth and seventh lead arsenate 4 pounds plus 1-1-100 zinc lime. Three pounds lead arsenate and 1-1-100 zinc lime in eighth and ninth.

Plat 9 - Same as plat 1 in calyx and first cover. Starting with second cover 6 pounds P. C. Mississippi Bentonite impregnated with 1 pound of DDT dissolved in Dioxane was used in all later covers, with the sulfur fungicide early as in plat 1.

Plat 10 - Same as plat 9 except 1/2 gallon of summer spray oil (Superla) was added in sixth, seventh, eighth, and ninth cover sprays.

Plat 11 - Same as plat 1 in calyx and first cover. Starting with the second cover lead arsenate 2 pounds and P. C. Mississippi Bentonite 1 pound impregnated with 4 ounces of DDT dissolved in Dioxane was used in all covers up to and including the ninth. Sulfur was used as in plat 1 and 1-1-100 zinc lime safener was used starting in the third cover.

Plat 12 - Same as plat 11 except no Bentonite was added.

Plat 13 - Same as plat 1 to and including 5th cover. Starting with the sixth cover 2 pounds Black Leaf 155 (7% nicotine) and 17% DDT plus 1/2 gallon of oil was added in all later sprays including the ninth cover.

Plat 14 - Same as plat 8 except 1 pound of Safe-N-lead, 1 pound for each 3 pounds of lead arsenate was substituted for the zinc lime safener.

Plat 15 - Same as plat 14 except 2 pounds of 155 and 1/2 gallon of summer oil was added to all sprays beginning with the sixth cover.

Plat 16 - Same as plat 15 except the Safe-N-lead was omitted.

Plat 17 - Fungicides as plat 1 - starting with the second cover DDT prepared by DuPont was used at 4 pounds per 100 gallons (1 pound actual DDT) in all later covers.

Plat 18 - Same as 17 except 2 1/2 pounds AK 40. DDT (1 pound actual DDT) was used instead of DuPont's DDT.

Plat 19 - Same as plat 18 except AKZ 40 DDT was substituted for AK 40.

Plat 20 - Same as plat 17 except 1 pound of Methasan as a fungicide was used instead of sulfur starting in the second cover and continued through the sixth cover after which the Methasan was omitted.

Plat 21 - Lead arsenate and fungicide as in plat 1 until the fourth cover. In the fourth cover the insecticide was changed to 1/2 strength DDT impregnated Bentonite as compared to plat 9.

Plat 22 - Same as plat 1 until fourth cover when 2 pounds of DuPont's 25% DDT (1/2 pound actual DDT) was used for the insecticide the remainder of the season.

Plat 23 - Used the lead arsenate program as in plat 8 until sixth cover at which time the lead arsenate was cut to 2 pounds and 1 pound of DuPont's formulation of DDT (4 ounces of actual DDT) was used the remainder of the season.

RESULTS

Small scale plats at Patterson Bain Orchard, Variety Jonathan

Plat No.	No. Trees	Treatment	% Clean	% Wormy	% Stung
1	2	155, 2 pounds plus 1 pint oil	79.3	13.9	6.6
2	3	155, 2 pounds plus 1 quart oil	82.4	13.9	3.5
3	5	155, 2 pounds plus 2 quarts oil	89.6	7.1	3.2
4	2	155, 3 pounds	76.6	19.8	3.4
5	7	Tank mix Nicotine Bentonite	89.2	7.4	3.4
6	3	155, 2 pounds, Dupont DDT, 4 ounces actual, 1/2 gallon oil	88.9	9	2
7	3	Tank mix DDT impregnated Bentonite oil and Nicotine	87.9	8.2	3.7
8	6	Lead Arsenate, Zinc Lime	83.4	10.2	6.2
9	3	DDT impregnated Bentonite 1 pound DDT	93.9	4.6	1.4
10	2	DDT impregnated Bentonite and oil	94.9	2.8	2.1
11	3	Lead Arsenate impregnated with 4 oz. DDT	83.1	12.5	4.3
12	3	Lead Arsenate and Bentonite impregnated with 4 ounces DDT	89.4	7.2	3.3

Results (Continued)

Plat No.	No. Trees	Treatment	% Clean	% Wormy	% Stung
13	2	155 and DDT prepared by Tobacco By Products Company	89.2	9.2	1.5
14	3	Lead Arsenate and Safe-N-Lead	81.9	13.8	4.2
15	3	Lead Arsenate, 155, oil, and Safe-N-Lead	87.7	8.7	3.5
16	2	155, Lead Arsenate and oil	88.3	7.5	4.1
17	3	DuPont DDT (1 pound actual DDT)	95.2	3.4	1.4
18	2	Geigy AK 40 at 1 pound actual DDT	93.4	5.3	1.2
19	3	Geigy AKT 40 at 1 pound actual DDT	90.2	8.3	1.4
20	2	Methasan plus 1 pound actual DDT	93.5	4	2.9
21	2	Bentonite impregnated with DDT, 3 pounds Bentonite and 1/2 pound DDT	87.3	9.6	3
22	2	DuPont DDT, 1/2 pound actual DDT	88.3	8.3	3.3
23	3	Lead Arsenate in first 5 covers had lead arsenate, 2 pounds, DDT, 4 ounces, in last 4 covers	94.8	2.8	2.4

Plats at Turner Station Orchard, Department of Horticulture, University of Missouri, Professor H. G. Swartwout cooperating.

Golden Delicious

Plat No.	Treatment	% Clean	% Wormy	% Stung	Total Apples
1	Lead and Zinc Lime early; oil and 155 later.	90.2	2.1	7.7	2390
2	DDT coated Methasan and Lead	85	8.7	6.2	900
3	DDT Methasan and Lead	91.3	2.7	5.9	1017
4	DDT coated Lead	93.6	.4	5.9	5943
5	DDT 1 lb. actual DDT	94.8	1.8	3.3	1261
6	DDT and Lead	92.8	2.4	4.7	3170
7	DDT coated Bentonite - 1 lb. DDT	95.8	1.2	2.9	3387
8	DDT coated Fermate and Lead	85.4	5.6	8.9	213
9	DDT Fermate and Lead	94.2	1.3	4.4	1182

NEW JERSEY

B. F. Driggers, New Jersey Agricultural Experiment Station,
New Brunswick.

Field Tests with DDT for the Control of Codling Moth on Apples, 1945

Preliminary laboratory and field tests with DDT (dichloro-diphenyl-trichloroethane) at the New Jersey Agricultural Experiment Station and elsewhere during 1943 and 1944 showed that DDT used at the rate of 1/2 to 1 pound in 100 gallons of water would kill recently hatched larvae and adults of the codling moth. Small scale field plot tests on peaches and apples during the season of 1944 showed that the chemical was compatible with most of the commonly used insecticides and fungicides, such as lead arsenate, lime, sulfur, oil, nicotine and copper. These experiments also indicated that DDT sprays caused a build-up of European red mite on apples and peaches sprayed with this chemical.

In order to obtain additional data on DDT as a control for codling moth and to study its effect on fruit and foliage when used alone and in combination with other chemicals, a series of experiments were laid out in a number of apple orchards in southern New Jersey. In most of the orchards the experiments were semi-demonstrational grower sprayed blocks in which the writer made observations and counts from time to time as the season advanced. In one orchard at Glassboro the writer helped spray the plots as well as make detailed observations and counts throughout the season. For convenience, the work will be summarized according to the orchards in which the work was done.

Alvin Magee Orchard, Glassboro, N. J.

Plans had been made to run a series of plots in the orchard of Mr. Alvin Magee at Glassboro in cooperation with the Tobacco By-Products and Chemical Corporation and others who applied insecticides for codling moth control. This orchard contained the varieties Rome Beauty and Red Delicious. The trees received the usual sprays of dinitro for aphid control in the dormant period, followed by lime sulfur at the prepink, wettable sulfur at the pink and wettable sulfur, lead arsenate and lime at the petal fall or calyx. A curculio spray of lead arsenate and fermate had been applied when a severe freeze ruined the Rome crop and greatly reduced the crop of Delicious.

Plot treatments were begun on Delicious at the second cover spray in May to test as a control for codling moth various DDT formulations in comparison with the standard lead arsenate-oil-nicotine non-wash schedule recommended by the New Jersey Agricultural Experiment Station for orchards in central and southern New Jersey. During the course of the season several DDT preparations supplied by the Tobacco By-Products and Chemical Corporation, one DDT preparation supplied by the Sherwin-Williams Company and a plant product, known as "Ryanex" and supplied by Merck and Company, were tested in comparison with the two standard spray schedules.

The detailed plot treatments as applied during first and second brood codling moth attack are set forth in Table 1.

Table I. Plot treatments for codling moth control on Delicious in Alvin Magee orchard at Glassboro.

Plot No.	Cover Sprays	Spray Materials in 100 Gallons Water	Date Applied
1	1	4# lead arsenate, 1# Fermate	May 2
	2	4# lead arsenate, 1# Fermate, 1 1/2# B.L. Dry Conc., 1 qt. oil	May 9
	3	3# lead arsenate, 1 1/2# B.L. Dry Conc., 3 qts. oil, 1-3-100 Bordeaux	May 17
	4	3# lead arsenate, 1 1/2# B.L. Dry Conc., 4 qts. oil, 1-3-100 Bordeaux	May 26
	5	3# lead arsenate, 1 1/2# B.L. Dry Conc., 4 qts. oil, 1-3-100 Bordeaux	June 5
	6	3# lead arsenate, 3 qts. oil, 1/2-4-100 Bordeaux	June 15
	7	2# Dry Conc./DDT, 2 qts. oil	June 28
	8	2# Dry Conc./DDT, 2 qts. oil	July 23
	9	2# Dry Conc./DDT, 2 qts. oil	Aug. 6
	10	2# Dry Conc./DDT, 2 qts. oil	Aug. 17
2	1 to 6	Same as plot 1	
	7	2# 155/DDT, 2 qts. oil	June 28
	8	2# 155/DDT, 2 qts. oil	July 23
	9	2# 155/DDT, 2 qts. oil	Aug. 6
	10	2# 155/DDT, 2 qts. oil	Aug. 17
3	1	4# lead arsenate, 1# Fermate	May 2
	2	3# B.L. 155/DDT, 1# Fermate, 1 qt. oil, 1/2 pt. B. L. 40	May 9
	3	2# B.L. 155/DDT, 3 qts. oil, 1/2 pt. B.L. 40, 1-3-100 Bordeaux	May 17
	4	2# B.L. 155/DDT, 4 qts. oil, 1/2 pt. B.L. 40, 1-3-100 Bordeaux	May 26
	5	2# B.L. 155/DDT, 4 qts. oil, 1/2 pt. B.L. 40, 1-3-100 Bordeaux	June 5
	6	2# B.L. 155/DDT, 3 qts. oil, 1/2-4-100 Bordeaux	June 15
	7	2# B.L. 155/DDT, 2 qts. oil	June 28
	8	2# B.L. 155/DDT, 2 qts. oil	July 23
	9	2# B.L. 155/DDT, 2 qts. oil	Aug. 6
	10	2# B.L. 155/DDT, 2 qts. oil	Aug. 17
4	1	4# lead arsenate, 1# Fermate	May 2
	2	4# lead arsenate, 1# Fermate, 1 qt. oil, 1/2 pt. B.L. 40	May 9
	3	3# lead arsenate, 3 qts. oil, 1/2 pt. B.L. 40, 1-3-100 Bordeaux	May 17
	4 and 5	3# lead arsenate, 4 qts. oil, 1/2 pt. B.L. 40, 1-3-100 Bordeaux	May 26 and June 5
	6	3# lead arsenate, 3 qts. oil, 1/2-4-100 Bordeaux	June 15
	7	3# lead arsenate, 1 qt. oil, 1/2-4-100 Bordeaux	June 28
	8	3# lead arsenate, 1 qt. oil, 1/2-4-100 Bordeaux	July 23
	9	2# lead arsenate, 3 qts. oil, 1/2-4-100 Bordeaux	Aug. 6
	10	3# lead arsenate, 1 qt. oil, 1/2-4-100 Bordeaux	Aug. 17

Table I - continued

Plot No.	Cover Sprays	Spray Materials in 100 Gallons Water	Date Applied
5	1	4# lead arsenate, 1# Fermate	May 2
	2-6	Same as plot 4	Same plot 4
	7	2# B.L. 155, 2 qts. oil	June 28
	8-10	Same as spray 7	July 23, Aug. 6 & 17
6	1-5	Same as plot 4	Same as plot 4
	6	3# Ryanex, 1 qt. oil	June 15
	7	4# Ryanex, 1 qt. oil	June 28
	8-10	4# Ryanex, 1 qt. oil	July 23, Aug. 6 & 17
7	1-6	Same as plot 4	Same dates
	7-10	2# DDT concentrate	Same dates
8	1-6	Same as plot 4	Same dates
	7-10	3# DDT concentrate	Same dates
9	1-6	Same as plot 4	Same dates
	7-8	1# Sherwin Williams 50% DDT	Same dates
	9-10	1 1/2# Sherwin Williams 50% DDT	Same dates
10	1-6	Same as plot 4	Same dates
	7-8	1# Sherwin Williams 50% DDT, 2 qts. oil	Same dates
	9-10	1 1/2# Sherwin Williams 50% DDT, 3 qts. oil	Same dates

Note: Cover sprays 1 to 7 inclusive covered the period of first brood larval attack; cover sprays 8 to 10 inclusive covered the period of second brood larval attack.

An examination of the dates of cover spray applications in Table 1 will show that there was a bunching of the cover sprays in the fore part of first brood at approximately 7-day intervals and a spreading to 10-12 day intervals the last part of first brood. This followed the recommendations as set forth in the New Jersey Agricultural Experiment Station spray recommendations. In practice the reverse should have been followed because May and the first half of June proved to be generally cool and wet whereas the last two weeks in June proved to be hot and dry. The most severe period of attack from first brood larvae occurred during the last two weeks of June when the 6th and 7th cover sprays were applied.

At the end of first brood worm attack and before second brood began (about the middle of July) the writer and two assistants made codling moth counts on the first six plots. Each man examined 100 apples on each of 5 trees in each plot using a step ladder and examining the fruit at random from the ground as high as could be reached from the top of the ladder. Thus 1500 apples were examined in each plot. The results from these end-of-first brood examinations are set forth in Table 2.

Table 2. Percentage codling moth injury on Delicious apples at Glassboro at end of first brood attack on plots receiving different spray treatments.

Plot No.	No. Apples Examined	Percent Codling Moth Injury	
		Stings	Worms
1	1500	45.7	1.2
2	1500	55.3	1.5
3	1500	16.1	0.1
4	1500	65.5	1.5
5	1500	51.3	2.0
6	1500	71.5	0.7

A study of the data in Table 2 will show that the outstanding difference in plot treatment is to be found in plot 3 which received B. L. 155/DDT throughout first brood attack. This plot was by far the cleanest plot both from the standpoint of stings and worms. Plot 6 is interesting because reference to Table 1 will show that the Ryanex sprays were begun at the 6th cover spray on June 15th and continued through the period of heavy first brood attack. This treatment did not stop stinging because this plot showed the highest percentage of stung fruit (71.5%) of any of the plots examined. However, the worms were not getting through because this plot next to plot 3 showed the lowest percentage deep entry.

It is doubtful if the switch in plot treatments at the 7th cover spray on June 28th on plots 1, 2 and 5 had much effect as regards first brood attack since the bulk of first brood larval hatching came before this spray was applied.

Reference to Table 1 again will show that a period of 25 days elapsed between the last first brood spray on June 28th and the first second brood spray on July 23rd. Subsequently, a second and third second brood spray was applied on August 6th and 17th, intervals respectively of 14 days and 11 days.

The fruit on the Delicious plots were harvested September 10-13, approximately four weeks after the last cover spray against second brood was applied. In making the counts all the fruit on four trees, both picks and drops, in each plot were examined for codling moth stings and worms. An effort was made to select in each plot 4 trees with uniform crops. No counts were made in plot 9, every tree in it had a heavy crop of fruit whereas in all other plots the crop was on the light side. The percentage of apples showing codling moth stings and worms on the various plots at harvest is set forth in Table 3.

Table 3. Relative codling moth control on Delicious apple plots at Glassboro sprayed with different spray materials.

Plot No.	Treatment	Total Apples 4 Trees	Percent Apples		
			Clean	Stung	Wormy
1	L.A.-oil-nic. then oil Dry Conc./DDT	1733	48.0	50.5	1.5
2	L.A.-oil-nic. then oil-B.L. 155/DDT	1892	22.6	72.8	4.6
3	Oil-B.L. 155/DDT	1521	77.2	20.2	2.6
4	L.A.-oil-nicotine	1639	10.9	75.8	13.3
5	L.A.-oil-nicotine, then oil-B.L. 155	2300	26.9	64.1	9.0
6	L.A.-oil-nicotine, then Ryanex-oil	2048	14.8	82.9	2.3
7	L.A.-oil-nicotine, then 2# DDT Conc.	1684	20.2	73.9	5.9
8	L.A.-oil-nicotine, then 3# DDT Conc.	1573	35.3	61.9	2.8
9	L.A.-oil-nicotine, then S.W. DDT	--	--	--	--
10	L.A.-oil-nicotine, then S.W. DDT	2587	27.9	68.0	4.1

A study of the data in Table 3 will show that all of the plot treatments were superior to the standard oil-lead arsenate (plot 4). Among the DDT spray combinations, plot 3, which received B.L. 155/DDT plus oil throughout the season was superior to all others. This plot came through with the lowest percentage of codling moth stings and worms. Comparing plots 1 and 2, the dry concentrate/DDT with oil was superior to the B. L. 155/DDT and oil. On plots 7 and 8, three pounds of DDT concentrate was superior to two pounds as was to be expected. Both plots, however, were superior to the standard oil-lead arsenate (plot 4) and the standard oil-nicotine (plot 5). The Ryanex-oil treatment (plot 6) came through with surprisingly few worms, being superior to the two standard treatments in this respect, but was quite high in percentage stings. The Sherwin-Williams DDT, used at 1/2 pound with oil (plot 10), was superior to the two standard treatments.

A careful check for foliage and fruit injury and red mite build-up was made throughout the season on the various plots. Plot 3 in particular, which received DDT throughout the season after the first cover spray, was observed. No foliage or fruit injury was observed on any of the DDT plots. Heavy red mite build-up occurred on all the plots sprayed with DDT, particularly plots 7, 8 and 9 which were sprayed with DDT through second brood without the addition of any summer oil. On these plots red mite build-up caused a distinct bronzing of the foliage by the end of July which interfered with the finish of the fruit and caused a premature dropping of the fruit and foliage. Red mite did not build up as early on those plots sprayed with DDT-oil and consequently the finish of the fruit was better. After the last spray of DDT-oil in mid-August the mite population built up on these plots but it came too late to cause much damage to the fruit.

C. B. Lewis Orchard, Burlington, N. J.

A demonstration block, testing DDT in combination with oil-lead arsenate, was arranged with Mr. C. B. Lewis at his Burlington orchard. A section of a block of Red Delicious, comprising about 100 trees, was sprayed with 1/2 pound of actual DDT to 100 gallons of oil-lead arsenate through first brood and with 1/2 pound of actual DDT plus oil for two cover sprays on second brood. This was compared with the standard non-wash schedule of oil-lead arsenate-nicotine for first brood followed by oil-nicotine for second brood on the remainder of the block. The essential difference between the two blocks was that in the first block 1/2 pound of DDT was substituted for 1/2 pint of nicotine. The DDT used was a 25 per-cent wettable powder supplied by the E. I. DuPont Company of Wilmington, Delaware.

On July 10th 1500 apples were examined at random in each of the two blocks of trees to determine relative codling moth control during first brood attack. The results are set forth in Table 4.

Table 4. Codling moth control at end of first brood on oil-lead arsenate-DDT plot compared to oil-lead arsenate-nicotine plot on Red Delicious on farm of Mr. C. B. Lewis at Burlington.

Plot No.	Treatment	No. Apples Examined	Percent Codling Moth Injury
1	Oil-L.A.-DDT	1500	4.8
2	Oil-L.A.-Nicotine	1500	18.0

The data in Table 4 show that codling moth control was better in the plot sprayed with oil-lead arsenate-DDT than on the plot sprayed with oil-lead arsenate-nicotine. There was 4.8 percent of the fruit showing stings and worms on the DDT plot as compared to 18 percent on the standard.

There was a marked build-up in European red mite on the DDT sprayed plot at the time codling moth counts were made on July 10th. By the first of August the foliage on the DDT plot was markedly bronzed and by harvest time the fruit was a dull color and dropping badly. European red mite built up on the standard sprayed block also but not nearly as heavily as on the DDT sprayed plot. The growers' reaction appeared to be that the gain in codling moth control was more than offset by the damage caused by red mite. In contrast to the results at Glassboro, red mite built up early and heavily in the Lewis orchard in spite of the fact that oil was used at a dilution strong enough to kill the mites. It should be pointed out that the block was sprayed with a Speed Sprayer and it has been observed that complete coverage of the under sides of the leaves in all parts of the tree is not accomplished with this type of spraying. This was observed in several orchards where DDT was applied with Speed Sprayers.

Byron Roberts Orchard, Marlton, N. J.

Another demonstration block using DDT was arranged for in the Lippincott orchard of Mr. Byron T. Roberts at Marlton. Two rows through the center of a Golden Delicious block of trees was sprayed through first brood using 1/2 pound actual DDT (2 pounds of DuPont 25% "Denate") added to 100 gallons of oil-lead arsenate. The remainder of the block was sprayed with oil-lead arsenate-nicotine.

On July 10th, at the end of first brood larval attack, 2000 apples were examined at random on the trees in each block. The results of these counts are set forth in Table 5.

Table 5. Codling moth control at end of first brood on oil-lead arsenate-DDT plot compared to oil-lead arsenate-nicotine plot on Golden Delicious on farm of Byron T. Roberts at Marlton.

Plot No.	Treatment	No. Apples Examined	Percent Codling Moth Injury
1	Oil-lead arsenate-DDT	2000	2.1
2	Oil-lead arsenate-nicotine	2000	6.2

The data in Table 5 from Golden Delicious in the Roberts orchard shows 2.1 percent codling moth injury in the DDT plot and 6.2 percent codling moth injury in the standard oil-lead arsenate-nicotine plot. Although total codling moth injury was lower in the Roberts orchard than in the Lewis orchard the percentage reduction in the two orchards was about the same, namely, about 75 percent.

In contrast to the Lewis orchard, red mite did not build up to any appreciable extent on the Golden Delicious in the Roberts orchard. This in spite of the fact that essentially the same schedule of oil-lead arsenate-DDT was used in both tests. The lack of red mite build-up on Golden Delicious was observed in other orchards besides the Roberts orchard. Just why red mite did not build up on this variety is, at present, not known. There is a possibility that Golden Delicious is more or less resistant to red mite. Over a period of years the writer has observed that Golden Delicious is less subject to red mite attack than Red Delicious or Stayman.

Seabrook Farms Orchard, Bridgeton, N. J.

A demonstrational block to be sprayed throughout first and second brood with DDT was arranged at the Seabrook farms orchards in a block of Golden Delicious. Cooperating in the demonstration was Dr. H. F Dietz of the DuPont Company who was to supply the necessary DDT, Dr. Frank App and Mr. Albert Sorn of the Seabrook Farms Company and the Entomology Department of the New Jersey Agricultural Experiment Station.

A block of approximately 25 Golden Delicious trees were selected in the center of a block where there was a heavy carry-over of codling moth from 1944. It was planned to spray this block with a Speed Sprayer using 4 pounds to 100 gallons of water of DuPont "Deenate," a formulation containing 25 percent technical DDT. The schedule called for spraying the DDT block the same number of times and on approximately the same day as the standard sprayed trees surrounding.

Before the DDT sprays were begun at the second cover spray the block had received a dormant spray of DNOC (sodium salt), a delayed dormant of lubricating oil emulsion, a pink of flotation sulfur, a calyx of lead arsenate and sulfur and a first cover of lead arsenate and Isothan Q 15. A total of 9 cover sprays using 4 pounds of Denate to 100 gallons of water was applied for first and second brood codling moth beginning at the second cover spray. The standard block was sprayed the same number of times using lead arsenate-oil-nicotine as outlined in the 1945 New Jersey Agricultural Experiment Station spray calendar for orchards in central and southern New Jersey.

On July 17th the writer and an assistant examined 1000 apples at random on the trees in each block to determine the percentage codling moth stings and worms at the end of first brood attack. The results are set forth in Table 6.

Table 6. Percentage codling moth injury on Golden Delicious apples sprayed with DDT compared to apples sprayed with oil-lead arsenate-nicotine.

Plot No.	Treatment	No. Apples Examined	Percent Apples Stung	Wormy
1	DDT	1000	4.8	0.0
2	Oil-L.A.-Nicotine	1000	64.3	0.8

The data in Table 6 show a marked reduction in codling moth injury on the DDT plot as compared to the standard lead arsenate-oil plot. Only 4.8 percent of the apples were stung as compared to 64.3 percent in the standard. No deep entries were found on the DDT plot whereas 0.8 percent of the apples examined in the standard plot showed deep entry. The low percentage of stung apples on the DDT plots indicates that the larvae or the adult moths or both were killed by the DDT before they succeeded in boring through the skin of the apple.

Doctors Dietz and Swingle of the DuPont Company made harvest counts on 6 trees in the DDT plot and 4 in the standard plot. The results of these counts kindly supplied by them are set forth in Table 7.

Table 7. Codling moth injury at harvest on Golden Delicious apples sprayed with DDT compared to standard sprayed fruit.

Plot No.	Treatment	Clean Apples	Wormy Apples	Stung Apples	Worms in 100 Fruits	Stings in 100 Fruits
1	DDT	87.5	3.2	9.3	3.2	12.7
2	Oil-L.A.-Nicotine	27.9	20.5	51.6	30.9	178.3

The data in Table 7 parallels the data in Table 6 and shows that the DDT sprayed fruit at harvest was considerably cleaner than the fruit sprayed with the standard sprays. Both as regards stings and worms the DDT was superior. Dr. Dietz's notes at harvest were as follows: Foliage condition excellent on the DDT, superior to the lead arsenate-oil standard; no scab on the DDT but a light infestation of black rot late in season; no sooty blotch; mite infestation none--Golden Delicious appears to be mite resistant."

The writer and Dr. Pepper examined the DDT sprayed plot at Seabrooks from time to time throughout the growing season. Our observations agree with those of Dr. Dietz for the most part. There was no evidence of mite build-up at any time during the season up to harvest. At harvest the foliage on the DDT plot appeared less injured than the foliage on the lead arsenate-oil plot. However, the foliage on the DDT sprayed trees was thinner than on the standard; there were less leaves on the DDT sprayed trees. This was due to the fact that from time to time during the season there would be yellowing and dropping of leaves on the DDT sprayed trees. This would usually start as a tip burn at the end of the leaf, the leaf would lose its dark green color and turn a pale yellowish green and finally would drop. In spite of this leaf drop the fruit at harvest on the DDT plot had sized well and had a better finish than the fruit on the standard sprayed plot.

NEW YORK

S. W. Harman, New York Agricultural Experiment Station, Geneva.

RESULTS OF CODLING MOTH INVESTIGATIONS IN WESTERN NEW YORK, 1945

I. Seasonal Conditions

Abnormal spring weather resulted in an almost complete apple crop failure for western New York in 1945. Aside from the scarcity of fruit the season was about normal with reference to codling moth activity and timing and number of cover sprays. Wherever there were apples there was also an abundance of codling moth. The second brood of worms continued to be active as late as mid-September.

II. Codling Moth Control with Sprays and Resulting Spray Residues.

A. Experimental Tests.

As a result of the scarcity of apples and the general interest in DDT most of the experimental effort was devoted to testing DDT preparations. The few additional materials tested including phenothiazine and Ryanex.

The data in Table I were taken from a 25 year old orchard of mixed varieties. Each treatment was made on several individual trees scattered at random throughout the planting and included the varieties Wealthy, McIntosh and Baldwin. This orchard was one of very few that bore a crop of fruit. The codling moth problem was not difficult. Four cover sprays were applied, three for the first brood on June 26, July 9 and 16 and one for the second brood on August 13.

Table I. Codling Moth Control - 1945

Material	Actual DDT in 100 gallons	Stings on 100 Apples	Worm holes in 100 Apples
	Pounds		
AK 40 (Geigy Co.)	1.0	2.6	0.7
AK 40	1.5	2.4	0.5
AK 40 + Lead arsenate 2 lb.	0.5	2.6	0.5
DDT Concentrate (Tob. By-Products)	0.5	2.7	1.0
DDT Concentrate	1.0	2.0	0.4
Black Leaf dry concentrate DDT blend (Tob. By-Products)	0.5	2.7	0.8
Deenate (DuPont)	1.0	3.8	0.9
Lead arsenate 3 lb. + Phenothiazine 2 lb.	-	7.5	1.1
Ryanex	-	23.0	10.3
Lead arsenate 3 lb.	-	25.8	2.4
Checks	-	42.4	85.5

Wherever DDT was used in the summer sprays practically perfect control of the codling moth resulted. There was considerable interest in the combination spray of phenothiazine and lead arsenate a year ago. This formula gave very good control but left some visible residue. Ryanex did not look too good when compared with the other sprays. It appeared to weather off rapidly. Lead arsenate showed its weakness in a large number of stings, but the infestation was not severe enough to bring out significant differences in worm control.

Spray deposits on the fruit at harvest resulting from the above are given in Table 2. DDT determinations were made by R. H. Washburn of Cornell University using the Gunther method. A. W. Avens of Geneva made the lead and arsenic analyses.

Table II. Spray Residue - 1945

	Actual DDT in 100 gallons	Grains per pound of Fruit		
		DDT	As	Pb
	Pounds			
AK 40	1.0	.012		
AK 40	1.5	.019		
AK 40 + Lead arsenate 2 lb	0.5	.006	.030	.068
DDT Concentrate	0.5	.017		
DDT Concentrate	1.0	.021		
Black Leaf dry concentrate DDT Blend	0.5	.002 (?)		
Deenate	1.0	.012		
Lead arsenate 3 lb. + Phenothiazine 2 lb.	-	-	.044	.092
Lead arsenate 3 lb.	-	-	.053	.118

B. Grower Tests

A very striking illustration of the superiority of DDT over lead arsenate was brought out in one of several grower tests in which the fruit grower did the spraying under the supervision of Experiment Station workers. For the past three years experimental tests had shown that lead arsenate could not handle the codling moth problem in this particular orchard. In 1944 ten cover sprays using double strength lead arsenate "spiked" with nicotine and with the addition of oil in seven of the cover sprays resulted in 30 percent severe codling moth damage on the test plats. Grower sprayed fruit showed 45 percent injury in the same orchard. In 1945 fruit sprayed with five cover sprays of 1 pound actual DDT in 100 gallons picked 99 percent free of all codling moth injury on trees bearing about 2/3 of a crop.

Unsprayed trees on this fruit farm were 100 percent wormy by early August and the entire crop dropped by the middle of the month due to worm injury. Individual fruits showed from several to as high as 38 active worm holes by mid-summer.

A similar experience occurred in a pear orchard on this same fruit farm. DDT sprayed pear trees were free of visible residue at harvest and not a single worm was found. The lead arsenate sprayed pears were literally white washed with arsenical residue and there were plenty of wormy fruits in evidence.

The apples sprayed with five cover sprays of DDT were well below the tolerance at harvest showing .036 grain DDT on McIntosh and .028 grain DDT per pound of fruit on the Delicious.

The residue data for DDT in all cases indicated that there should be little or no difficulty in meeting the present tentative tolerance after using five cover sprays of DDT on apples.

III. Injury

Nothing of an injurious nature developed on either foliage or fruit as a result of the use of DDT sprays during 1945.

IV. European Red Mite

It is very possible that western New York orchards may develop trouble from the European Red Mite in the future, however, after two years of field tests this mite has not as yet developed to problem proportions on apples as a result of using DDT sprays.

OHIO

C. R. Cutright, Ohio Agricultural Experiment Station, Wooster.

I. Seasonal Conditions and Codling Moth Abundance.

Temperatures far above normal in March and April produced blossoming and with the petal-fall spray about three weeks ahead of normal. Codling moth larvae pupated as early as April 8 at Wooster. Frosts in late April and poor pollinating weather reduced the Ohio crop to its lowest point in 40 years. Very cool weather in May and the first half of June retarded codling moth activity, but the light crop showed a higher percentage of injured fruit than normal. In a few orchards that had a normal crop, codling moth was not too difficult to control.

Summary of Codling Moth Biology, Ohio, 1945

	Wooster (N.E. Central)	Lorain (North)	Port Clinton (N.W.)
Spring-brood Emergence			
First moth	May 3	May 21	May 11
50%	May 21	June 3	May 31
Last moth	June 19	July 4	July 1
Summer-brood Moth Emergence			
First moth	July 24	Aug. 6	July 26
50%	Aug. 5	Aug. 15	Aug. 16
Last moth	Aug. 29	Aug. 26	Aug. 28
First-brood Larvae under Bands			
First larvae	July 1	July 13	July 10
Peak	July 18	Aug. 17	Aug. 15

II. Control Experiments in 1945.

Due to severe frosts and a very poor set of fruit, field spray plots were less in number than usual. However, one layout of 19 treatments was conducted at Lorain, Ohio. Also, 10 Ohio growers applied one or more experimental DDT schedules on blocks of trees in their orchards. The results in such experimental blocks were then compared with those on the blocks sprayed with recommended schedules. These tests by growers were well scattered over Ohio.

The results of these tests in six problem orchards have been summarized by Professor T. H. Parks as follows:

DDT Schedules .....0.5% wormy 2.6% stung
Standard Schedules ...6.4% wormy 33.0% stung

The plot layout at Lorain was applied on 35-year old Jonathan trees which, due to frosts, etc., were carrying a rather light and irregular crop of fruit. Single-tree plots, replicated five times, were used. The experimental block was surrounded by a grower-sprayed orchard that was heavily infested.

All plots received lead arsenate in the petal-fall and 1st cover sprays. Plots were differentiated with the 2nd cover which was applied May 31 and June 1. These succeeding applications were then made at 2-week intervals until July 9-10. Two applications against the 2nd brood were made on August 2 and on August 21-22. The late date of the last application was chosen to determine its effects on spray residues. The schedule and the control obtained on significant plots are given in the following table.

Codling Moth Control at Lorain, Ohio

Plot	Materials	% wormy	% stung only	% total injury by codling moth
1	Lead arsenate 3# Phenothiazine 2# (1)	19.6	32.2	51.8
3	Lead arsenate 3# Oil 3/4 gal. (3)	16.9	33.9	50.7
4	Lead arsenate 3# Oil 3/4 gal. (4) B. L. 40 1/2 pt. (4)	14.9	26.2	41.3
5	B. L. 155, 2# Summer oil 1/2 gal. Fermate	26.7	16.6	43.4
6	Tank mix, B. L. 40, 1/2 pt. Miss. Bentonite 4#, oil 1/2 gal., DDT 1/4 lb.actual	2.4	7.5	9.9
7	Lead arsenate 3# Oil 3/4 gal. (7) Fermate (7)	12.4	24.7	37.1
8	Lead arsenate 3# DDT 1/2# actual (8)	8.5	18.0	26.5
9	B. L. 155 (7%) DDT (17%) } 2#	18.3	20.3	38.6
10	DDT 25% 1/2# actual	2.6	8.4	11.1
11	DDT 25% 1# actual	.5	3.0	3.5
13	DDT 25% 1# actual Fermate (13) Oil (13)	.9	2.9	3.8
14	DDT 50% 1/2# actual Exp. Lot 1.	3.7	8.6	12.2
16	DDT 50% 1/2# actual Exp. Lot 3.	12.8	17.7	30.5
19	DDT 40% 1# actual (19)	.8	5.5	6.3

Notes on schedule:

(1) Phenothiazine in 2nd, 3rd, and 4th covers only.

(3) Summer oil in 2nd, 3rd, and 4th covers only.

(4) Summer oil in 2nd, 3rd, and 4th covers only. Black Leaf 40 in 2nd, 3rd, 4th, and 5th covers only.

(7) Summer oil in 2nd, 3rd, and 4th covers only. Fermate 1 pound in 2nd, 3rd, 5th, and 6th covers only.

(8) DDT in 2nd, 3rd, and 4th covers only.

(13) Summer oil same as No. 3. Fermate same as No. 7.

(19) DDT by Geigy Co., all other by DuPont (Deenate 25 w or 50 w or Exp. Lots).

Notes on control:

The table shows the excellent control obtained by schedules where DDT was predominant as an insecticide. Note relatively poor control on Plot 8, as compared with good control on Plot 10. Also, the contrast between Plots 5, 6, and 9. The poor results with a poor formulation of DDT are evident in Plot 16.

Notes on injury:

Little or no injury from spray materials to foliage was observed on any of the plots. However, the schedule used on Plot 13 caused the dropping of many young fruits in late June and early July.

European Red Mite as Affected by DDT Schedules

On the plots at Lorain, red mite developed to a serious extent on all plots, with the exception of 5 and 6, where oil was used throughout the season. The infestation on Plots 3, 7, and 13 was later in developing but by September 1 was near 20 mites per leaf. Most DDT plots carried populations of from 20 to 25 mites per leaf from August 15 to September 10. The injury, though serious, was not so severe that it would preclude the use of DDT.

At Wooster, Ohio, DDT schedules produced heavy and long drawn-out mite infestations. Infestation was retarded and lightened by the use of a dormant oil spray. Also, infestations were fairly well controlled by combining DDT and DN-111 in two or more cover sprays. However, in two out of three grower tests where this combination was used

on Jonathan, premature dropping of a portion of the crop occurred. There was also some defoliation. Numerous other varieties were not affected.

Of the 10 grower tests, four developed serious mite injury. Two had some injury, and the others none of importance. None of these growers had severe mite injury on blocks sprayed with recommended schedules. The season of 1945, however, was very unfavorable for mites.

OKLAHOMA

F. E. Whitehead, Oklahoma Agricultural Experiment Station, Stillwater.

The codling moth infestation in eastern Oklahoma was the lowest in 1945 than it has been for several years. It is thought that this condition was due, in a large measure, to an unusual amount of cold rainy weather during the emergence of the overwintering brood. Even in unsprayed and in poorly sprayed orchards, infestations were very light until the middle of July, after which infestations climbed rapidly except in well sprayed orchards. In the western part of the State, the major portion of moth emergence occurred after the cold weather and infestations were about normal.

DDT was used in three orchards during the 1945 season. In each case, one row of trees was sprayed with DDT by the same crew and, at the same time, the balance of the orchard was sprayed with arsenate of lead. An average of six percent better control of codling moths was obtained with DDT than with arsenate of lead. Also, in each case, mites became a severe problem on the trees sprayed with DDT.

The greater portion of the experimental work conducted on codling moth control was to determine the effect on codling moth populations of the planting of entire orchards to varieties ripening during the summer months. Theoretically, such an orchard should suffer less codling moth injury for two reasons: (1) In such an orchard, but two generations of moths would have time to develop rather than three and a partial fourth generation that normally develop in Oklahoma orchards containing late fall varieties. (2) The hibernating population would be greatly reduced since the major portion of those hibernating develop on the later varieties of apples.

To obtain better information concerning the second point, mature larvae were collected from under burlap bands, placed in pupation sticks and records kept as to when they pupated or entered hibernation. During the past three seasons, such records were obtained on a total of 12,927 larvae from five different locations. Of the larvae collected, 4634 entered hibernation. The average percentages of these hibernating larvae that had entered hibernation throughout the summer and fall months are shown in the following table.

Date	Percent of total hibernating populations	Date	Percent of total hibernating populations
June 25	.04	Sept. 3	42.1
30	.06	8	50.0
July 5	.08	13	60.3
10	.21	18	68.8
15	.37	23	75.2
20	.56	28	82.7
25	1.01	Oct. 3	88.5
30	1.77	8	91.6
Aug. 4	3.56	13	93.6
9	5.54	18	95.4
14	8.89	23	96.5
19	13.9	28	99.1
24	22.0	Nov. 1	100.0
29	30.4		

These data indicate that, if all the apples in these orchards had been picked by the middle of August, approximately 91 percent of the hibernating population would have been eliminated. Since each of these orchards contained late fall varieties, it is also indicated that the codling moth populations at the beginning of the season was more than ten times as great as it would have been had only summer varieties been present.

Had the percentage of control been the same, less than one percent of the normal hibernating population would have entered hibernation in orchards containing only varieties ripening by mid-August. It seems probable that such a reduction would constitute control.

Since, under Oklahoma conditions, the earlier apples are cheaper to produce and normally bring better prices than the later varieties, it appears that the planting of orchards containing only varieties ripening not later than mid-August would be practical as well as effective in controlling codling moths.

OREGON

Leroy Childs and R. H. Robinson, Hood River Branch Experiment Station, Hood River, and Oregon Agricultural Experiment Station, Corvallis.

Codling Moth Abundance: Codling moth was more abundant and caused more damage generally than usually obtains. Overwintering moth emergence was long drawn out which was reflected in considerable late worm activity taking place at a time when the last spray cover was becoming partially ineffective. Rain and wind interfered at the time of the calyx application, causing delay which, without quention, contributed to worm increase. Windy weather also prevailed during the early cover periods which, together with the fact that many growers were employing untrained spray men--many of them Mexicans--tree tops were not thoroughly sprayed.

Experimental Area: The results from spray usuage discussed in this report, were confined to applications made on the Newtown variety. The investigation for the most part, was conducted at the Experiment Station. Nineteen-year-old trees (D Series) employed in these tests were confined to a single compact block. All were quite uniformly loaded, producing approximately 20 boxes each. Location of the plots is shown in the accompanying diagram. Apples surrounding these plots were sprayed with a calyx and 5 covers of lead and Fluxit and this program, due to extensive infestations in some of the experiment plots, was insufficient to affect good control. Worm entrance of 8 to 10 percent occurred with stung apples ranging up to 30 percent. Pears are planted on the North side of the experimental plot. This area was quite free from worm damage. Random apple samples were taken from each box of fruit from 3 trees in each plot. Two hundred and fifty apples, as outlined in the project, were taken from these replicates. Picked fruit only was used. First brood damage was determined, Table I, before fruit drop.

Materials used were as follows:

DDT (Deenate 25W)	E. I. DuPont Co., N. Y.
DDT (Gesarol AK 40)	Geigy Co., N. Y.
Gesafloc (liquid soap)	Geigy Co., N. Y.
Colloidal Depositor	Colloidal Products, San Francisco
Colloidal 77	Colloidal Products, San Francisco
Fluxit	Colloidal Products, San Francisco
Shell Light Oil	Shell Oil Co., San Francisco
Kryocide	Pennsylvania Salt Co., Tacoma, Wash.
Lead Arsenate	General Chemical Co.

Discussion of Project. Results obtained in 1944 employing a regular or 5-cover schedule indicated that DDT was far superior to any material previously employed. Sprays containing both 1 and 2 pounds actual DDT (1) produced fruit 98% plus free from worm injury. One test, sprayed in the first three covers only, resulted in the production of 99% of the apples free from worm damage. From these observations, three important possibilities, insofar as future investigational work was concerned, were obvious. They are (1) Reduction of the number of covers - a departure from the old program of conventional 5 to 7 cover sprays and its relation.

Table I. Codling Moth Tests, Hood River, Oregon - 1945
(All dilutions based upon 100 gallons; DDT expressed as actual)

Experiment No.	Number Cover Sprays	Spray Dates	Material Used	Percent Worms	Percent Stings	Percent Clean	1st Brood "hits" per 100 Apples 3/
D-1	1 1/	June 6	DDT 1 pound Nacconol 2 oz.	18.1	16.4	72.5	3.3
D-2	2	June 6 July 12	Same as above	2.6	3.9	93.7	3.3
D-3	2	June 6 July 12	DDT 1/2 pound Nacconol 2 oz.	7.1	6.9	87.6	3.2
D-4	2	June 6 July 12	DDT 1/4 pound Nacconol	15.0	17.3	73.4	7.0
D-5	3	June 6 July 12 Aug. 3	DDT 1/4 pound Nacconol 2 oz.	6.9	10.8	84.9	3.7
D-6	2	June 6 July 12	DDT 1/2 pound Nacconol 2 oz. Shell light 1 qt.	13.8	15.8	74.2	4.3
D-7	2	June 6 Aug. 3	Same as above Oil 1 1/4 gal.	10.1	15.6	77.7	4.9
D-8	1	June 6	DDT 1/2 pound Col. Depositor 1/2 Shell light 1 qt.	23.8	17.8	64.7	2.6
D-9	2	June 6 Aug. 3	DDT 1/2 lb. 1st spray Gesafloc 1 pt. 2/ DDT 9/10 pound	1.2	5.7	93.2	2.5
D-10	3	June 6 June 26 Aug. 3	DDT 1/2 pound DN 111 3/4 pound. 1/2 pound 2 & 3 Sprays	5.3	12.1	84.4	3.5
D-11	5	June 6 June 25 July 11 Aug. 4, 22	Kryocide 3 pounds Coll. 77, 1/3 pound Shell light 2 qt.	9.9	34.8	60.0	8.5
D-12	5	Same	Ars. Lead 3 lb. Coll. 77, 1/3 lb. Shell light 2 qt.	7.9	31.8	64.4	8.3

1/ All tests in this table received a calyx spray Ars. 3-100; Fluxit 1/4-100 May 10, 1945.

2/ Due to error 9/10 lb.-100 DDT was employed. This consisted of 5/10 lb. DDT from Deenate 25 W and 4/10 lb. from Gesarol AK 40. No spreader was added in August 3 application.

3/ Randomized counts made on four sides of three trees from bottom to top. Most of the injury found above 12 feet. Figures therefore do not express percentage of fruit injury as fruit below 12 feet. Area of greatest production was relatively clean, especially in the DDT plots.

Table I-A. Arrangement of DDT plots at Station, 1945 (Adjacent rows four trees deep)(See Table I for complete list of materials used and dates of application. DDT in all plots except 11, 12 and S-5)

Row	Experiment No.	DDT used (pounds)	Number of Covers	Worm Injury % Wormy	% Stung	% Clean	1st Brood "hits" per 100 Apples 4/
1	D-12	1/	5	7.9	31.8	64.4	8.3
2							
3	D-1	1	1	18.1	16.4	72.5	3.3
4	D-2	1	2	2.6	3.9	93.7	2.2
5	D-3	1/2	2	7.1	6.9	87.6	3.2
6	D-4	1/4	2	15.0	17.3	73.4	7.0
7							
S. 8	D-11	2/	5	9.9	34.8	60.0	8.5 N.
9	D-5	1/4	3	6.9	10.8	84.9	3.7
10	D-6	1/2 with Oil 1 qt.	2	13.8	15.8	74.2	4.3
11	D-7	1/2 with (oil 1 1/4)	2	10.1	15.6	77.7	4.9
12	D-8	1/2	1	23.8	17.8	64.7	2.6
13	D-9	1/2 - 1st 9/10 - 2nd	2	1.2	5.7	93.2	2.5
14	D-10	1/2 (DN-111)	3	5.3	12.1	84.4	3.5
15	D-11						
16		2/	5	11.8	27.6	65.8	9.2
17	S-5	3/	5	24.0	51.4	40.6	9.7
18							
19							

1/ Ars. Lead 3-100, light oil 2 qt.

2/ Kryocide 3-100, light oil 2 qt.

3/ Ars. Lead 3-100; Fluxit 1/4-100 (Average wormy entrants in orchard surrounding DDT area on South and East, was 17.1%, some sprays poorly applied.)

4/ See Note 3, Table I.

to possible saving in cash and labor costs. (2) Dilution needed to effect control with (1) in mind. (3) Elimination of the calyx spray as a result of DDT usage. (4) Study of coverage, lasting effects, residue at harvest in relation to the three previous objectives.

Based upon the objectives outlined, the 1945 investigations were very definitely exploratory in nature. Major interests centered in what DDT would not do rather than its opposite. In this respect the results obtained point to the fact we were not disappointed. Table I outlines spray dates, number of applications, materials used and control obtained. Unfortunately one test employing a complete or conventional cover program of DDT was not included. A test of this sort would have been of value for comparative purposes. However, the DDT tests can be directly compared with a calyx and 5-cover program employing lead arsenate - oil in one and Kryocide - oil in another which are enlightening. Due to the extensive moth increase in some of the DDT plots and the resulting exposure to attack in the lead and Kryocide tests, the coverages in the latter proved inadequate. The percentage of both worms and stings was far greater than has obtained during the past four or five years during which time these and other combinations have been under observation in the Station orchard. In these control plots for the DDT tests, the results were as follows: Lead arsenate - oil (D-12 Table I) 7.9 percent wormy fruit; 31.8 percent "stings" and 64.4 percent clean apples; for Kryocide - oil, 9.9 percent wormy; 34.9 percent stung and 60.0 percent free from worm damage. These tests and all of the DDT plots were sprayed by one and the same spray man throughout the spray season. The average condition of the fruit adjacent to the experimental area sprayed with arsenate of lead, 3 pounds, Fluxit 1/4 pound was 17.1 percent wormy; 45.2 percent stung and 50.3 percent clean. This portion of the orchard was sprayed by inexperienced help at times of various applications, a condition which, together with the extensive wormy increase in some of the experimental plots, had much to do with the abnormal increase.

From this discussion it is obvious that the experimental plots were adequately exposed to an extensive moth population. DDT was used at the rate of 1 1/2 and 1/4 pounds actual DDT. One to three covers employing a number of spreaders and stickers, were applied. All of the DDT tests produced a higher percentage of clean fruit than where the regular programs were employed, however, a number were much wormier than the latter, the difference being made up in the noticeable increase in stung fruit where the generally used insecticides were employed.

The original plan of the investigation was to apply sprays as needed and not follow any set program. The procedure seemed to operate satisfactorily during the first brood, but was not altogether satisfactory later. It was then decided to let nature take its course with a number of applications as we wanted to find out just what one or two or three sprays would accomplish. A very direct comparison (see map of plots) can be made in connection with the results obtained in Experiments D-1, D-2 and D-12. (1) These plots are adjacent. All of the tests at the Station (Table I) received a calyx of lead arsenate 3 pounds and Fluxit 1/4 pound; all of the DDT tests except W-1 and W-2 discussed later, were likewise so sprayed. D-1 received but one cover spray, 1 pound actual DDT applied June 6 prior to first brood egg hatch employing Nacconol as a spreader. D-2 two covers applied as above and again on July 12 at the time of the normal third cover

(1) With the exception of D-9, source of DDT from Deenate 25 W.

in the regular program. No second brood activity had started and was not expected for some time. D-12 was sprayed in the calyx and followed by 5 covers of lead arsenate - oil. Results obtained in these three tests were as follows: Clean fruit, D-1, 72.5 percent; D-2 93.7 percent and D-12 64.4 percent; wormy fruit, D-1, 18.1 percent; D-2 2.6 percent and D-12 7.9 percent; stings D-1 16.4 percent; D-2, 3.9 percent and D-12, 31.8 percent. (See Table I.)

One half pound actual DDT was applied in 3 tests D-3, D-6 and D-7 light oil being used in the two latter tests. D-3 and D-6 were sprayed on the same dates as in D-2, that is, June 6 and July 12. D-7 received the second application on August 3. In these experiments the percentage of actual wormy fruit was found to be noticeably higher as compared to the pound usage. In the oil containing sprays the percentage of worminess was found to be nearly twice that of the application of the DDT dosage containing no oil. The data appears to indicate that the addition of oil to DDT does not improve control, but may actually reduce its effectiveness. In these 1/2 pound DDT tests, the material used without oil (D-3) permitted 7.1 percent worm entrants, 6.9 percent stung fruit and 87.6 percent free from worm damage, whereas D-6 (DDT with 1 quart of oil) the comparable test, allowed the entrance of 13.8 percent worms, 15.8 percent "stings" and 74.2 percent free from codling moth injury. D-7 using 1 1/4 gallons of oil, 10.1 percent worminess occurred with 15.6 percent "stings". In this test 77.7 percent of the fruit was found to be free from worm damage. The results obtained suggest that combinations used with DDT may materially influence the effectiveness of this new insecticide.

One quarter of a pound of actual DDT as used in our tests proved inadequate One test D-4 was sprayed on June 6 and July 12; a second test, D-5, was sprayed three times, June 6, June 25 and August 3. In the former, 15.0 percent of the fruit became wormy; 17.3 percent developed stings with 73.4 percent free from worm injury at harvest. In the latter, 6.9 percent became wormy; 10.8 percent of the apples were stung and 84.9 percent were found undamaged when picked. Total worm damage--wormy and stung--was less than occurred in both of the conventional 5-spray programs where lead arsenate or Kryocide were employed. Material reduction in the number of stung apples in the DDT plots was largely responsible for the fact that there was less total worm damage.

One test was applied employing DDT 1/2 pound to which 1/2 pound of DN-111 was added. This experiment was included for the purpose of observing effects on 2-spotted mite development (T. willamettii), possible injury to trees and fruit and influence of the addition to the insecticidal value of DDT in relation to codling moth control. Three applications were made June 6, June 25 and August 3. No injury resulted. Codling moth control was not as effective as obtained in the adjacent 2-spray program test employing DDT alone with a spreader-sticker. 5.3 percent wormy apples; 12.1 percent "stings" and 84.4 percent clean fruit, were found at harvest in the DDT-DN experiment, whereas, the adjacent plot D-9 sprayed twice (June 6 and August 3) using 1/2 pound in the first and 9/10 pound in the second but 1.2 percent worms, 5.7 percent "stings" and 93.2 percent uninjured fruit were recorded. Effects on mites will be discussed later.

Test in an abandoned orchard: For the purpose of exposing DDT to maximum moth infestation applied in a limited schedule, two tests were made in an abandoned orchard. No sprays in any form have been applied during the past six years. During this period from 90 to 100 of the fruit had become wormy.

Table II. Codling Moth Tests - 1945. Mosier Tests - Wilcox Orchard 1/
No calyx spray.

Exp. No.	No. Sprays	Spray Dates	Material Used	% Worms	% Stings	% Clean
W-1	2	June 15 July 31	1st spray DDT 1 lb. Gesafloc 1 pt. 2nd spray DDT 1.5 lb. 2/	2.1	6.0	91.8
W-2	1	June 15	DDT 1 pound, Gesafloc 1 pt.	34.0	17.4	56.8
W. Ck.	0	--	None	90.8	.9	8.2

1/ Abandoned orchard, no sprays applied for six years, apples 90 to 100 percent wormy during this period--no calyx spray applied in these tests.

2/ DDT a mixture of 1 pound from Deenate 25 W and 1/2 pound Gesarol AK 40.

Table III. First Brood Injury Above Test. Count made July 31, 1945.
Randomized examination on three trees.

Exp. No.	No. Sprays	Spray Date	Apples Examined	Injured 1/	% Injured	Calyx Injury	Percent Calyx Injury Basis Total Apples	Basis Total Injuries
W-1	1	June 15	1500	101	6.7	24	1.6	23.8
Ck.	No. spr.	--	1500	794	52.9	243	16.2	30.6

1/ Stings and worms.

No sprays other than the DDT experiments were applied in this orchard during 1945. Surrounded by unsprayed trees, eight trees were sprayed, 1 pound DDT (Deenate 25 plus Gesafloc 1 pint-100) on June 15, four of which were re-sprayed on July 31. The second application consisted of 1.5 pounds - 100 DDT. (1 pound in the form of Deenate 25W and 1/2 pound Gesarol AK 40 1/). The trees are approximately 30 years of age of medium size and received between 25 to 30 gallons in each application.

1/ The addition of the Gesarol was in error; had planned to use Gesafloc.

All portions of the trees were thoroughly covered including the lower as well as the upper leaf surfaces. The variety sprayed was Newtown. On this sort approximately 75 percent of the codling moth egg deposit is made on the lower surfaces of the leaves. The more important information desired in connection with this investigation involved the following: (1) Effect of one and two sprays of DDT on the control of codling moth applied under conditions of undisturbed maximum population and attack. (2) Killing effect of DDT applied to apples into which worms had entered before the spray was applied. (3) Elimination of the calyx spray as the result of DDT usage as cover sprays. The 1944 results indicated the calyx spray might be abandoned where DDT was employed in three or more covers. No calyx spray was applied in these tests.

Two DDT covers, 1 pound in the first and 1.5 pounds in the second, thoroughly applied and timed for first and second brood control resulted in 91.8 of the apples free from worm damage. Worms entered 2.1 percent and stung 6.0 percent of the crop on the sprayed trees. One application caused noticeable reduction of worm damage Table II. Considering the extensiveness of the moth population about the sprayed trees the protection exerted by this new insecticide was indeed remarkable. As has been stated earlier in the discussion, the trees have been entirely neglected during recent years. The trees have been making little or no growth. The 1945 crop was abundant and not thinned, resulting in the production of very small apples. This condition doubtless favored control, due to slow surface expansion of the fruit and a retarded thinning out of the surface of spray on the fruit. Our observations carried on over a period of many years indicate that small apples sprayed in the same manner as large apples, are usually less wormy. More rapid thinning down or "growing out" of the spray cover, appears to have something to do with the greater number of worms entering large fruits. On the other hand the large apple possesses a far greater surface area than the small one with the result there exists greater opportunity for worm entrance.

Spray effect on worms entered before spraying: On various occasions we have observed that nicotine-oil combinations destroy many young worms where such combinations have been applied after worm entrance had taken place. No careful study has been made to determine the depth to which worms may enter the apples and still be affected by this poison. In order to observe whether or not DDT might perform in the same manner, the first cover was purposely delayed in the Mosier experiment previously discussed. Some first brood worms were entering the fruit at the time the spray was applied. A record of depth of penetration was not made. As a general statement, it may be said 1/4 to 5/16 inch involved the deepest average penetration with a good many worms nearer the surface. One worm in the fruits examined had reached the seed cavity. It was in a sprayed apple and found dead. The worm injuries and burrows were all opened and examined. A record was made of injuries and burrows containing living worms, dead worms and burrows from which the insects were missing. These data are summarized in Table IV. The results obtained in this observation indicate a control factor, not operative in the case of insecticides most commonly used for codling moth control, performs under certain conditions at least, in the case of DDT applications. Approximately a week after the spray was applied, 7.7 percent living worms were found in the burrows from fruit

taken on the sprayed trees, whereas, 67.3 percent contained insects from fruit not sprayed. Expressed in another way, 32.7 percent of the injured unsprayed apples were free from worms while 92.3 percent were worm free where the spray was applied. If this performance prevails under all sorts of conditions, such as period of attack weather conditions and the like, greater latitude in the timing of sprays would follow.

Will a calyx spray be necessary where DDT covers are employed? Limited evidence gathered to date indicates the calyx spray can be dropped from the spray program where DDT is used in a cover program. Table III presents some data involving this feature of codling moth control. In the Mosier experiment where no calyx spray was employed, the character of first brood worm activity was analyzed. Fruit counts were made on July 31 at the end of first brood activity. The apples on unsprayed trees showed a total worm damage of 52.9 percent of which 16.2 percent indicated entrance by way of the calyx cup.

In the test where DDT had been employed in one spray up to the time the records were taken, worm injury to the extent of 6.7 percent occurred. Of this percentage, 1.6 percent showed calyx injury. These figures and other accumulated data demonstrate the fact that calyx worms enter apples in very limited numbers where DDT has been applied in covers sufficient to prevent 2 percent or less wormy fruit. Further analyses of the data presented in Table III points out the fact that DDT applied as cover applications, does not act like lead arsenate applied as a calyx spray where worms are destroyed following such usage. Calculating the character of damage on the basis of ratio of total worm injured fruit, to fruit showing calyx injury, it is found that 30.6 percent of the injured apples on the unsprayed trees indicated calyx entrance, whereas, 23.8 percent of the injured apples on the DDT plot were so attacked. In other words, DDT does not destroy calyx worms as such but rather so affects the young insects before they reach the calyx cup, the major portion of them are unable to enter.

DDT and San Jose Scale control: The trees in the abandoned orchard sprayed at Mosier, were all severely infested with San Jose scale. Most of the branches in the lower frame work of the trees were extensively encrusted with some of the smaller branches apparently killed by this insect. Counts made at harvest time clearly show the effects of DDT in the reduction of "crawlers" that reached the fruit. These observations are summarized in Table V. 26.4 percent of the fruit on the unsprayed trees was found to be scaly. The range of injury on the trees checked was from 18 percent to 32 percent; where one spray of a pound of DDT was employed 2.3 percent developed ranging on the checked trees from .8 to 3.2 percent. Where two sprays were employed the first as above and the second 1.5 pounds DDT an average infestation of .8 percent occurred. On the trees in this experiment the injured fruits ranged from .0 to 1.2 percent. The percentages do not indicate the degree of attack. Most of the infested apples on the unsprayed trees were severely blotched by numerous insects whereas on the sprayed fruit, infestation was often limited to one or two insects only. The fact that scale was being controlled was not recognized early enough to determine effects on the mother insects. It seems logical to believe, however, if the crawler population is eliminated there would occur little or no carry-over into the

Table IV. Effects of DDT on young worms that have entered apples before spraying. (First brood worms sprayed June 15; results check June 20. 1/)

Experiment No.	Injured apples examined	Sample No.	Total	With living worms	With dead worms present	With worms missing	Percent Injuries with living worms
W-3	25	1	27	18	3	6	
No spray	25	2	28	19	2	7	
Total	50	-	55	37	5	13	67.3 3/
W-1 2/	25	1	27	0	13	14	
	25	2	25	4	11	10	
Total	50	-	52	4	24	24	7.7

1/ A few worms started entering a week to 10 days before the spray was applied.

2/ Spray contained 1 pound actual DDT plus 1 pint-100 Gesafloc spreader.

3/ Where no spray was employed, 32.7 percent of the injuries and burrows contained no worms, whereas in the sprayed fruit, 92.3 percent were found to be free from living worms.

Table V. Effect of DDT on San Jose Scale - Mosier. Wilcox Orchard, 1945.

Experiment No.	No. of Sprays	Spray Dates		Percent Apples with scale
W-2	2	June 15; July 31.	1st spray, DDT 1 lb. + Gesafloc 1 pt. 2nd spray DDT 1.5 lb.	.8 1/
W-1	1	June 15	DDT 1 lb., Gesafloc 1 pt.	2.3 1/
Ck.	No spray	--	--	26.4 2/

1/ Most apples with one or two scales only.

2/ Scales usually numerous with apples severely blotched.

following year and control of the insects would thus be obtained. Further observations will be made on these trees in 1946.

Willamette mite (Two-spotted mite). Nothing of a specific character can be expressed relative to mite performance and control in the various experimental plots during the past season. Foliage injury was recorded July 30th and October 25 in the form of symbols. (x - slight; xx - noticeable; xxx - intensive; xxxx - extensive with some leaf drop.) There occurred considerable difference in the degree of injury on trees within an experiment as well as an apparent variation in population over the experimental plots as a whole. The most seriously injured plot was D-1 (sprayed once, 1 pound DDT on June 6th). This was followed by D-2 and D-3 (See Table I for program and materials used). The least injured by mite was D-7 sprayed twice with 1/2 pound DDT with 1 1/4 gallons light oil. This was followed by D-6 one half pound DDT in two sprays using 1 quart light oil. Relatively slight mite damage occurred in Experiment D-8 sprayed once with 1/2 pound DDT (June 6) to which was added 1 quart light oil. The infestation in Experiment D-10 (DDT 1/2 pound, DN-111 1/2 pound in 3 sprays) was slightly more noticeable than in the two preceding tests. The mites although abundant in this group of sprays containing an aracnicide caused no appreciable commercial damage to the fruit. Mite damage was extensive in all of the other DDT tests at the Station with probable fruit size reduction although this was not measured. No mite damage occurred on trees surrounding the DDT plots and mites were difficult to find.

An extensive early mite population developed on all of the trees sprayed with DDT at the Station in 1944. The leaves were generally yellow throughout the season and there occurred some premature leaf drop. Nearby unsprayed trees were practically free from mite attack and remained so throughout the season. It is interesting to note that no visible mite injury occurred on the trees sprayed at Mosier. The same condition obtained on the unsprayed trees. Within a quarter of a mile from these tests, an unsprayed cherry orchard was practically defoliated by the Pacific mite, T. pacificus. The trees in the Mosier experiment are very low in vigor having made practically no terminal growth during recent years. The foliage is good in the early season, however, and the trees set a heavy crop of fruit every other year. Little woolly aphis increase likewise occurred on these trees. Their physical condition as expressed by vegetative performance, was opposite of that prevailing at the Station where both pests were extremely abundant. From these observations it would appear that tree condition has a good deal to do with the development of these two pests where DDT is employed.

DDT and Woolly Aphis development: Woolly aphis developed extensively in all of the DDT plots at the Station as was the case in 1944. Although no refined method of measuring differences was developed, crude visual observations recorded in symbols (x - 25%; xx - 50%; xxx - 75%; xxxx - 100% aphis development) taken twice (July 30 and October 25) on each tree in the sprayed plots demonstrated varying degree of aphis attack in the different plots and that changes occurred during the season depending upon the time the trees were sprayed and to some extent the dosage of DDT applied. The trees in Experiment D-2, sprayed twice with 1 pound of DDT, were most constantly and apparently most severely attacked. Maximum attack was maintained

throughout the season on the trees in this plot, whereas the degree of aphis attack was similar in D-1 (sprayed June 6 only with 1 pound of DDT) on July 30 but steadily dropped and was recorded as a 50 percent infestation on October 25 as compared to 100 percent for D-2. This reduction was largely due to the activities of syrphid larvae and A. mali. Lightest infestation occurred in Experiment D-6 sprayed only once, June 6, with 1/2 pound DDT. Aphis prevalence closely followed this condition in D-4, sprayedtwice with 1/4 pound and D-7 sprayed twice with 1/2 pound DDT to which was added 1 1/4 gallons light oil. There likewise occured a lighter infestation in D-10 where DN-111 was used in three covers with 1/2 pound DDT as compared to the maximum infestation found in D-2. Where three applications of 1/4 pound was employed--the last on August 3--a maximum condition of aphis attack developed by the end of the season.

Spray Deposits of DDT on Newtown Apples from the Hood River Station Experimental Plots

Chemical analyses were made for the amount of DDT spray deposit on Newtown apples collected from the Hood River Branch Station experimental plots. Since no definite schedule was followed in the application of the spray to the various plots, samples were collected at five different periods during the growing season. When sampled in June and July, 25 to 30 apples were taken, and later when the apples were larger, 16 to 22 apples were picked for the analyses. The apples were stripped with benzene, dehydrohalogenated with alcoholic potash and the DDT calculated from the chloride ion liberated. From these results it would seem that there is a relatively rapid breakdown of the DDT leaving practically only trace amounts after a month's time. This observation is further confirmed by analyses of leaves. For example, leaves collected from plot D-1 showed 120.7 micrograms DDT per square centimeter immediately after spraying, 11.5 micrograms per square centimeter one month later, and 1.9 micrograms three months after application. In this plot only one spray was applied using the DDT at the rate of one pound to 100 gallons. Care was taken to collect leaves at each sampling that were fully grown at the time of application of the spray on June 6. In like manner leaves from plot 4 showed a decrease from 72.0 micrograms per square centimeter on June 6 to 6.4 micrograms a month later on July 6. It is possible that decomposition of the DDT may have been accelerated by the use of the Nacconol NR spreader used in these sprays. This material is one of the wetting agents which consisted of alkyl, aryl sulfonate 50 percent and filler 50 percent.

In one plot where a potash soap was used as a spreader and flocculater, higher deposits persisted throughout the season which indicates a slower decomposition of the DDT.

Limited washing tests carried on this season confirm observations made for the 1944 season.

Washing tests were carried on with apples picked from several of the experimental plots, but because of the high toxicity to codling moth larvae of the DDT, it is improbable that removal of the latter need be

considered. The plot showing highest deposit of DDT at harvest carried only .037 grain DDT per pound. Vatsol added to a Cutler overhead flood washer to the point of foaming cleaned this sample down to .032 grain per pound. Apples from other plots where the amount at harvest ranged from .014 grain per pound to .022 grain per pound cleaned down to .013 to .020 grain per pound. The apples from all experimental plots were well below the unofficial tolerance of .05 grain DDT per pound of fruit.

Table VI. DDT on Apples, Hood River Station. (Oil dilutions based upon 100 gallons; DDT expressed as actual)

Plot No.	Spray Treatment	After June 6 Spray	July 6	Before and after Aug. 3 Spray	Sept. 6	At Harvest
		Micrograms DDT per Sq. cm.				
D-1	DDT 1 lb. + Nac. 2 oz. 1 cover spray June 6.	23.1	7.4	-	1.3	1.6
D-2	As D-1 but 2 applications June 6 and July 12.	21.5	-	After 8.6	4.2	1.8
D-3	As D-2 but .5 lb. DDT	10.9	5.2	After 4.1	2.7	2.6
D-4	As D-2 but .25 lb. DDT	4.7	1.0	After 2.5	1.7	1.9
D-5	As D-4 but sprayed June 6, June 25 and August 3.	-	-	Before 3.9 After 5.5	4.0	1.8
D-6	DDT .5 lb. + Nac. 2 oz. + oil 1qt. on June 6 and July 12	9.2	4.2	After 5.3	2.7	1.7
D-7	DDT .5 lb. + Nac. 2 oz. + oil 5 qt. on June 6 and August 6	11.8	2.6	Before 1.4 After 5.1	3.0	3.7
D-8	DDT .5 lb. + colloidal depositor 1/3 lb. + 1 qt. oil on June 6.	14.5	11.6	2.1	2.4	1.6
D-9	DDT (AK 40) .5 lb. + Gesafloc (a) 1 pt. on June 6 and August 3 2/	11.1	8.6	Before 1.9 After 9.1	7.1	4.6
D-10	DDT .5 lb. + DN 111 .75 lb. on June 6; 1/2 lb. June 26 & Aug. 3	10.4	3.4	Before 1.0 After 10.8	3.0	2.3
W-2	DDT 1 lb. + Gesafloc 1 pt. on June 16.		9.9		3.4	
W-1	DDT 1 lb. + Gesafloc 1 pt. June 13 and DDT 1.5 lb. July 31		-		4.9	

1/ Nacconol NR; 2 ounces of 50 percent product used; (a) Gesafloc a potash liquid soap.

2/ Due to error 9/10 DDT used in 2nd spray with no spreader.

OREGON (Continued)

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Seasonal Conditions and Codling Moth Abundance

The spring of 1945 was rather cool. The month of April was abnormally dry, with little rainfall, while during May there was excessive rainfall, with few days without rain. This made it very difficult for growers to apply their early cover sprays on time. As a result, some of the early worms were able to establish themselves, and second brood attack was heavy. Fruit harvest again was much later than normal.

A calyx and six cover sprays were recommended for apples and late pear varieties, and a calyx and five cover sprays for Bartlett pears. Many growers were able to apply only one of the first two cover sprays because of rain and muddy conditions in the orchards. This was also true in the case of the experimental plots.

Results of Control Experiments

Tests for codling moth control were carried on in a commercial Bartlett orchard. Each plot consisted of eight trees--four random replicates of two trees each. All of the fruit, both from the tree and on the ground, was examined for worm injury from all trees in each plot. Standard plots received a calyx and four cover sprays. DDT plots received only three cover sprays, with or without a calyx spray of lead arsenate. Dates of application were as follows: calyx, May 1; 1st cover, June 7; 2nd cover, June 22; 3rd cover, July 18; 4th cover, August 13. The fruit was harvested at one picking, August 31 to September 5.

Tests were also carried on in the station orchard on Anjou, Bartlett, Bosc, Comice, and Winter Nelis pear varieties. The trees are planted in blocks of six rows of five trees each for each variety. All trees received a calyx application of 3 pounds lead arsenate, 2 ounces deposit builder, 1 quart stove oil. The west row of each variety received 4 cover sprays of .4 pound of actual DDT in 100 gallons, the remainder of each block received the regular lead arsenate treatment--4 covers for Bartlett and 5 covers for the other varieties. The fruit from one or two trees in each of the DDT sprayed rows was examined for worm injury and a like number in the adjoining lead arsenate sprayed trees. Dates of application: calyx, May 17; 1st cover, June 8; 2nd cover, June 25; 3rd cover, July 17; 4th cover, August 8; 5th cover, August 22. Bartlett pears were picked August 24; Anjou, September 12; Bosc, September 17; Comice, October 5.

Sprays were applied with a Bean portable sprayer at a pressure of 400 to 450 pounds at the pump, using two leads of hose with single spray guns with 7/64 inch openings in the discs.

A. Control by Insecticides

(1) Lead arsenate gave good control when used at the rate of 3 pounds in 100 gallons in combination with deposit builders and stove oil, however, several other materials gave better control.

(3) Fluorine compounds--natural cryolite, 3 pounds in 100 gallons, with deposit builder and stove oil, used in all of the cover sprays, gave better control than lead arsenate. Synthetic cryolite used in the same manner gave somewhat poorer control than lead arsenate.

(5) Organic materials:

(a) DDT gave outstanding control when used at the rate of .4 pound actual DDT in 100 gallons, in 3 or 4 cover sprays, with or without a calyx spray of lead arsenate. However, the injury from spider mite was much more severe on DDT sprayed trees than on those sprayed with lead arsenate. In the station orchard the use of 3/4 pound summer dinitro spray and 1/3 pound deposit builder with the DDT kept the mites in check. About 6 1/2 percent of Bartlett pears sprayed with this combination showed a light to heavy, reddish-brown blotching on the skin. Injured pears were in or near the top of trees where they were exposed to full sunlight.

(b) Micronized phenothiazine, 1 1/2 pounds in 100 gallons with dry deposit builder in all cover sprays gave better control than lead arsenate.

(c) Xanthone, 2 pounds in 100 gallons, with deposit builder and stove oil, in all covers, gave control about as good as lead arsenate and the trees sprayed with this material were very free from spider mite injury.

Residue and Its Removal

Samples of fruit were washed in a commercial Cutler washer in an unheated acid bath of 1 3/4 percent strength. DDT sprayed fruit was first dipped into a solution of 1 ounce of Vatsol in 10 gallons of water. One sample of each lot was left unwashed. Cryolite sprayed fruit cleaned to .034 grain of fluorine per pound of fruit. Very little of the DDT residue was removed by washing, however, even in the case of 4 cover sprays of .4 pound of DDT on Bosc pears, which have a russetted surface, the residue on unwashed fruit was only .027 grain per pound. This cleaned to .020

grain per pound. The highest residue on unwashed Bartlett pears receiving 3 cover sprays of .4 pound DDT was .022 which cleaned to .017 and .013 grain per pound. Apparently the residue at harvest is not a problem, even on unwashed fruit.

Control in Commercial Bartlett Orchard

Plot No.	Materials 1/	% Calyx Injured	% Side Injured	% Total Wormy	Av. No. Fruits Per Tree
1	Lead ars.-d.b.-stove oil 2/ Brand 4, all sprays (check)	0.6	2.9	3.5	1,549
2	Lead ars.-d.b.-stove oil Brand 7a, all sprays	0.4	2.2	2.6	1,480
3	Lead ars.-d.b.-stove oil Brand 3, all sprays	0.6	2.2	2.8	1,495
4	No Calyx; .4 lb. DDT, 1/2 pt. soap spreader, 1, 3, and 4 3/	0.1	0.3	0.4	1,338
5	Lead ars.-d.b.-stove oil in calyx; .4 lb. DDT, 1/2 pt. soap spreader in 1, 3 and 4. 3/	0.0	0.4	0.4	1,580
6	Lead ars.-d.b.-stove oil in calyx; Syn. cryolite-d.b.-stove oil in covers	0.1	4.2	4.3	1,284
7	Lead ars.-d.b.-stove oil in calyx; Nat. cryolite-d.b.-stove oil in covers	0.5	1.0	1.5	1,188
8	Lead ars.-d.b.-stove oil in calyx; Xanthone-d.b.-stove oil in covers	1.0	3.0	4.0	1,362
9	Lead ars.-d.b.-stove oil in calyx; Micron. Phenothiazine-d.b. in covers	0.5	1.1	1.6	1,580
10	Lead ars.-d.b.-stove oil in calyx; .2 lb. DDT-blood albumen spreader in 1, 2, and 4. 3/	0.1	0.8	0.9	1,589
11	Lead ars.-d.b.-stove oil in calyx; .4 lb. DDT-d.b.-stove oil in 1, 3, and 4. 3/	0.1	0.2	0.3	1,472
12	Lead ars.-d.b.-stove oil in calyx; .4 lb. DDT, 1/2 pt. soap spreader in 1, 2, and 3. 3/	0.0	0.4	0.4	1,190

1/ Lead arsenate, cryolite were used at the rate of 3 pounds in 100 gallons; xanthone, 2 pounds; micronized phenothiazine, 1 1/2 pounds; deposit builders, 4 ounces (2 ounces in plots 2, 3); blood albumen spreader, 4 ounces; stove oil, 1 quart.

2/ Brand 4 lead arsenate was used wherever the brand is not given.

3/ DDT plots received only 3 cover sprays.

Control in Station Orchard

Variety 1/	Material and 2/ Numbersof Covers	Calyx Injured	Side Injured	Total Wormy	Stung Fruit
		%	%	%	%
Anjou	DDT, 4 covers	0.0	2.4	2.4	5.8
	Lead arsenate, 5 covers	0.0	9.5	9.5	5.8
Bartlett	DDT, 4 covers	0.6	0.6	1.2	1.0
	Lead arsenate, 4 covers	2.0	6.6	8.6	1.7
Bosc	DDT, 4 covers	0.0	1.1	1.1	4.5
	Lead arsenate, 5 covers	1.4	10.5	11.9	3.3
Comice	DDT, 4 covers	0.0	1.0	1.0	1.4
	Lead arsenate, 5 covers	4.2	1.9	6.1	4.2

1/ Number of trees counted for each treatment--Anjou, 2; Bartlett, 1; Bosc, 2; Comice, 1.

2/ Three pounds lead arsenate, 2 ounces deposit builder, 1 quart stove oil in the calyx, 1st, 2nd, and 5th covers; 3/4 pound summer dinitro, 1/3 pound deposit builder with the lead arsenate in the 3rd and 4th covers. .4 pound DDT, 1/2 pint soap spreader in 1st and 2nd cover sprays; .4 pound DDT, 3/4 pound summer dinitro, 1/3 pound deposit builder in 3rd and 4th covers (lead arsenate in calyx).

PENNSYLVANIA

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SEASONAL DEVELOPMENTS

The season of 1945 opened earlier than any since 1921. Low temperatures of 26.5-27°F. during early stages of bloom on April 6 and 7 and of 27-28°F. on May 2, two weeks after petal-fall of Stayman, thinned and destroyed many crops. Although the crop was but 30 percent of normal, there were many orchards that bore high yields of clean fruit among previously heavy codling moth infestations.

Some of the greatest improvements in commercial codling moth control occurred in "problem" orchards and some failures occurred where short spray schedules were followed.

Spring brood emergence began April 12 and continued in cages until June 21. Cloudy weather and haze for prolonged periods helped to delay the ending of moth emergence from deep crevices and pruning stubs. First brood emergence occurred in cages between July 10 and August 15 and a few 2nd-brood moths emerged between August 25 and September 7. Moths were taken in bait pails from April 27 to September 23, with a peak nightly catch of 1004 moths in 10 traps on May 21.

There were eggs in the red-ring stage on May 15 and many in the black-spot stage on May 21, but there were no signs of hatching until May 29 on south slopes near Arendtsville. There was no difference in date of first hatching on north and south slopes but peak hatching differed by 7 days and ending of heavy hatching differed by 12 days on north and south slopes at the same elevation. On a south slope, 24 percent of the fruits on trees sprayed with lead arsenate-lime were stung or wormy on June 1, 3 days after first stinging took place. Codling moth attack was generally light between June 1 and 11, heavy in all orchards from June 12 to 29, when the mean temperature for the 18 day period was 76°F., and heavy on a NE slope until July 11. Second brood attack began on July 21 but was not generally heavy until August 2, continuing heavy until August 23. First instar larvae were found until September 29 but the September attack was lighter than in 3 previous seasons.

Weather and codling moth records taken at 710' to 750' elevation are summarized in Table 1.

Table 1: Weather conditions, moth emergence and bait pail catches at weekly intervals in test orchards at Arendtsville, Pa. 1945

Week Ending:	Max. °F.	Mean °F. at 8 PM.	Rain Inches:	Moth (cage) Emergence:	WEEKLY BAIT PAIL CATCHES *		
					NE Slope:	West Slope:	Per cent Females:
Apr. 17	84	59	0.98	14	0	0	-
Apr. 24	67	48	0.44	17	0	0	-
May 1	72	47	2.20	42	16	14	3
May 8	76	48	1.11	25	23	31	31
May 15	85	59	0.70	122	292	493	26
May 22	84	61	2.22	185	357	990	32
May 29	79	60	1.52	186	203	292	31
June 5	75	57	0.32	158	220	482	30
June 12	87	64	1.10	103	201	198	34
June 19	94	74	0.49	53	96	227	40
June 26	94	69	0.43	1	256	192	24
July 3	98	75	0.51	0	227	75	29
July 10	89	73	0.14	2	62	14	55
July 17	84	68	0.74	21	22	17	60
July 24	91	76	1.14	84	55	53	50
July 31	93	72	1.03	108	216	78	35
Aug. 7	91	71	1.93	52	281	253	43
Aug. 14	89	69	0.20	27	119	130	49
Aug. 21	89	69	0.61	6	120	103	38
Aug. 28	90	64	2.63	2	192	155	37
Sept. 4	92	70	0.97	3	156	110	43
Sept. 11	86	68	0.10	1	4	4	37
Sept. 18	84	62	4.32	0	6	5	18
Sept. 25	85	62	0.70	0	3	3	100
Oct. 2	85	61	0.28	0	0	0	-

*Double quart traps of paired baits were used. The traps were baited with 10% No. 10 brown sugar plus 1 cc nicotine sulfate per qt. ½ cc oil of sassafras was added to one quart of each double trap. The baits were changed between broods. They were refilled with fresh 5% brown sugar solution and nicotine sulfate was added each week. Five double traps were used on each slope. Of the total 6748 moths taken in 10 traps, 4416 were taken in the sides containing oil of sassafras.

CONTROL BY INSECTICIDES

Phenothiazine, DDT, lead arsenate and the nicotines were compared in small plots and the commercial use of phenothiazine was followed.

Test sprays were applied to six varieties that yielded an average of 3 to 20 bushels of picked fruit per tree. Summer Rambo was lightest and Smokehouse heaviest in yield. The test trees had suffered from drought and from nutritional deficiencies in the two previous years. Cortland had showed greatest injury from internal cork in 1944 and did not fully recover in the wet season of 1945.

In 1944, the test trees had been severely infested with codling moth, although 7 cover sprays had been applied by the grower. The 1944 infestation had ranged from approximately 1200 to 4000 worm holes per tree and the fruits had contained approximately 100 to 600 stings per 100 apples.

Cortland, Stayman, Smokehouse, Rome Beauty and Summer Rambo lost most of their center blossoms in the early freeze and the surviving buds set fruit in clusters that were not thinned. Red Delicious bloomed lightly but set well with few apples in clusters.

Cortland, Red Delicious, Smokehouse, Summer Rambo and Rome Beauty test trees (18 yrs. old) were on a southeast slope dropping from approximately 750' to 720' elevation in descending order as listed. Stayman were large mature trees at about 750' elevation on a southwest slope. The Cortland and Stayman trees each bordered old orchards that had also harbored extreme codling moth infestations in 1944.

Nine treatments on Cortland and Red Delicious were replicated 4 times on each variety. Four treatments on Stayman were replicated 8 times. Nine treatments on Smokehouse were replicated twice. Four treatments on Summer Rambo were replicated 4 times. The remaining 4 treatments were each applied to 4 x 5 blocks of Rome Beauty trees by the grower under supervision. All drops were scored at frequent intervals during the season. Tree fruits were sampled at the close of first brood attack and at harvest.

Approximately 70,000 lbs. of micronized, unconditioned phenothiazine was used mostly in the middle three of the first five sprays applied after petal-fall by 50 growers in southern Pennsylvania during 1945. The material was used in combination with lead arsenate only against heavy infestations. York Imperial was the principal variety sprayed followed by Stayman, Rome Beauty, Black Twig, Grimes Golden, Golden Delicious, Jonathan, Summer Rambo, Yellow Transparent, Smokehouse, Red Delicious and Cortland. Approximately one-half of the orchards were visited but counts were made only in orchards adjacent to Arendtsville, where the 1944 infestations had been counted. In 800 acres of orchards within 5 miles of Arendtsville, that were sprayed with approximately 25,000 lbs. of phenothiazine, more than 200,000 bushels of apples were produced that suffered approximately 10 per cent of the codling moth injury of the previous year. Some well sprayed blocks suffered about 1 per cent of the previous year's injury.

The results of codling moth treatments are given in tables 2 to 6 inclusive. DDT at 1 lb. per 100 gallons was the most effective spray. In some treatments, phenothiazine-lead arsenate combinations equalled or exceeded the control value of DDT combinations containing $\frac{1}{2}$ lb. or less of DDT per 100 gallons.

Spray injury: The foliage on DDT sprayed trees, where no other materials were included, was equal to that on any other treatments until the late build-up of mites caused earlier leaf-fall. Summer oil in combination with DDT-nicotines produced leaf-drop on Rome amounting to approximately 25 per cent of the foliage in the first week after application although the first use of summer oil was delayed until 31 days after the last sulfur spray. However, these trees were weak and on thin soil. No further injury was observed from 3 later sprays.

DN-111 and Delmo Z, each used with DDT and lead arsenate in 3 of the first brood covers produced injury by browning the under sides of leaves in the second application made in cool, humid weather. (60°F.) No visible injury had resulted from the first application of these two treatments and no further injury was observed from the final application applied in hot weather (89°F.) but the injury that occurred to foliage was accompanied by a greatly increased June drop; the crops of 3 varieties were greatly reduced by the injury and the surviving fruits of Stayman showed severe russet around the calyx end and lower side of the fruit. The harvest drop of most trees sprayed with DDT was slightly greater than where phenothiazine-lead arsenate or Bordeaux-lead arsenate mixtures were used. The foliage of trees sprayed with DDT mostly dropped in October, while trees sprayed with phenothiazine-lead arsenate still retained most of their leaves until mid-November.

Phenothiazine was superior to lime or to weak Bordeaux mixture as a buffer against arsenical injury under the extreme weather conditions of 1945. The size of Stayman fruits was reduced where lime was used with phenothiazine-lead arsenate or where lime had been used in preliminary sprays. Lime also caused injury to the upper surfaces of mid-ribs and secondary veins of leaves, when followed by phenothiazine-lead arsenate sprays. On the other hand, the splitting of Stayman attributed to frost injury and to growing conditions, was less severe where phenothiazine-lead arsenate was used after flotation sulfur-lead arsenate-lime than where other preliminary sprays or DDT-lead arsenate was used.

Superior foliage and fruit developed on experimental and commercially sprayed trees where lead arsenate was used with flotation sulfur paste or with sulfur paste and Fermate in petal-fall and first cover sprays and then with phenothiazine in 3 covers followed by weak Bordeaux mixture alone and with Orthex.

Where phenothiazine was used with kerosene-soap or Orthex in combination with lead arsenate in second brood sprays applied in hot weather, the fruits of some varieties were green at harvest and the spray residue was heavy. A scald developed on Rome Beauty where Orthex was used with phenothiazine and lead arsenate in hot weather and the drops rotted quickly.

Summer oils in second brood sprays dulled the fruit color and finish in all cases where used in 1945.

Red color development was retarded where phenothiazine was used alone but near normal where phenothiazine was used with lead arsenate. Where phenothiazine-lead arsenate was followed by weak Bordeaux-lead arsenate, red color development in fruits was superior to that produced where a full schedule of weak Bordeaux-lead arsenate was used. Where phenothiazine-lead arsenate followed Bordeaux too closely (12 days) the normal lively green foliage color was dulled, as where it was used after lime. The fruits of Jonathan, normally russetted by copper sprays, were not russetted and showed exceptionally good finish where 3 weak Bordeaux-lead arsenate sprays followed 3 phenothiazine-lead arsenate sprays, in the wet season of 1945.

In the experiments reported here, phenothiazine has been used with lead arsenate and also with flotation sulfur, Nicotine Dry Concentrate or Multifilm as wetting agents. In these tests, phenothiazine was water-pasted with other agents before adding it to the spray tank.

Flotation sulfur paste did not depress the control of codling moth by phenothiazine but sulfur scald has occurred where the maximum temperature immediately following applications ranged from 89°F.- 94°F.

The visible residue of phenothiazine-lead arsenate was readily removed from the cheeks of apples by brushing. The finish of Yellow Transparent, Summer Rambo and other early apples after brushing was excellent. The visible residues of DDT sprays applied within 6 weeks of harvest could not be entirely removed by brushing, except where Bordeaux mixture had been included in the late sprays.

Effects of materials on minor pests: Wooly and green aphids increased markedly during and soon after applications of phenothiazine. Syrphid flies were killed by phenothiazine. However, parasitism increased greatly and the aphid infestations subsided without producing economic damage. Where Nicotine Dry Concentrate was used with phenothiazine, the leafminer Lithocolletes crataegella did not cause injury nor did aphids, leafhoppers or other foliage pests. Hymenopterous parasites of aphids, leafhoppers, leafminers and codling moth were more common on trees sprayed with phenothiazine than on trees sprayed with nicotine, oil, DDT or Bordeaux-lead arsenate. European red mite and Tetranychus mites caused no bronzing where phenothiazine was used, except where delayed dormant oils were not used. Predators of the European red mite did not appear to be harmed by phenothiazine sprays.

DDT in the middle 3 of five first brood codling moth sprays of lead arsenate controlled the pear borer, where DDT was used at ½ lb. per 100 gallons of spray. The clear wing moths were found in great numbers in bait pails in late May and June of 1945. No leafhoppers were found on any DDT sprayed trees. Grasshoppers were not affected by the concentrations of DDT used against codling moth. The above mentioned leafminer was controlled by two or more consecutive sprays of DDT at ½ lb. or more per 100 gallons of spray, in codling moth sprays. Wooly and green aphids were held in check by DDT at ½ lb. per 100 gallons in first and second brood codling moth sprays. However, where DDT was used at ½ lb. with lead arsenate in the middle three of five first brood cover sprays, an extreme wooly aphid infestation developed late in the season with a very low rate of parasitism. European red mite was checked by early cool weather but mite increases together with Tetranychus mites did not cause bronzing in some cases until after harvest, where oils had been used at delayed dormant, and where DDT was used in summer sprays. Most of the mite predators were killed by DDT.

Table 2 A: Codling moth sprays; Cortland and Red Delicious, 1945:

Treatment number:	Preliminary sprays * alike to all trees: Petal-fall-April 21 Curculio or first cover spray-May 12	Test treatments for heavy hatching of the first brood: 2nd cover - May 21 3rd cover - June 1 4th cover - June 13	Spray for stragglers of first brood: 5th cover- June 25	Test treatments for heavy hatching of the second brood: 6th cover - July 23 7th and final cover - August 9.
	Covers in which materials were used:	Materials and rates per 100 gallons of spray:		
1	2,3,4,5,6,7	Lead arsenate 3 lbs.	Bordeaux mixture ½-2-100	
2	2,3,4,6,7	Lead arsenate 3 lbs.	Phenothiazine 2 lbs.	
	5 only	Lead arsenate 3 lbs.	Bordeaux mixture ½-2-100	
3	2,3,4,5	Lead arsenate 3 lbs.	Phenothiazine 2 lbs.	
	6 and 7	Lead arsenate 3 lbs.	Phenothiazine 2 lbs.	
		Kerosene 1 qt.	Multifilm 6 oz.	
4	2,3,4	Lead arsenate 3 lbs.	Phenothiazine 2 lbs. Flotation sulfur paste 3 lbs.	
	5 only	Lead arsenate 3 lbs.	Bordeaux mixture ½-2-100	
	6 and 7	Orthol K, 2 qts.	BL-155 2 lbs.	
5	2,3, only	Lead arsenate 3 lbs.	Phenothiazine 2 lbs.	Nicotine DC 2 lb
	4,5, only	Phenothiazine 2 lbs.	Nicotine Dry Concentrate 2 lbs.	
	6 and 7	Orthol K, 2 qts.	BL-155 2 lbs.	
6	2,3,4,6,7	DDT 1 lb.	(Deenate 4 lbs.)	
	5 only	DDT ½ lb.	Bordeaux mixture ½-2-100	
7	2,3,4,6,7	DDT ½ lb.	Lead arsenate 3 lbs.	
	5 only	DDT ½ lb.	Bordeaux mixture ½-2-100	
8	2,3,4 only	DDT ½ lb.	Lead arsenate 3 lbs. DN-111 1¼ lbs.	
	5 only	DDT ½ lb.	Bordeaux mixture ½-2-100	
	6 and 7	DDT ½ lb.		
9	2,3,4 only	DDT ½ lb.	Lead arsenate 3 lbs. Uramon 1 lb.	G-Frits 1 lb.
	5 only	DDT ½ lb.	Bordeaux mixture ½-2-100	
	6 and 7	DDT ½ lb.	G-Frits 1 lb.	

* The petal-fall spray was applied by the grower and consisted of flotation sulfur paste 12 lbs. Lead arsenate 3 lbs.
The first cover was applied by the laboratory crew and consisted of Camden sulfur paste 10 lbs. Lead arsenate 3 lbs. Uramon 5 lbs.
The test cover sprays were applied from the ground to the insides and outsides of the trees. The timing interval of first brood was kept at 11 to 12 days although improved control could have been obtained by shortening the spray interval. The second brood sprays were stretched to 17 days during a period of heavy hatching in order to gain greater differences between treatments.

Table 2 B: Codling moth sprays: Cortland and Red Delicious, 1945:

Results against codling moth: Sprays listed in table 2 A:

Treatment Number:	Total fruits Per tree:	Per cent June drops:	Per cent picked fruits:	Per cent clean fruits:	Per cent wormy:	Worm holes per tree: 1st Br:	2nd Br:
Variety Cortland:							
1	2706	32	38	48	44	565	1654
2	2432	34	48	78	14	82	355
3	2242	32	50	85	10	49	226
4	2817	34	45	68	26	73	1013
5	2609	33	48	76	21	28	719
6	2249	30	53	94	3	20	70
7	2327	34	50	94	4	17	113
8	2863	60	30	95	3	9	81
9	2749	29	53	93	4	12	123
Variety Red Delicious:							
1	2095	15	70	78	8	48	162
2	2145	16	73	90	4	13	69
3	1724	14	73	91	3	7	46
4	2220	21	69	89	6	12	122
5	1652	16	70	91	6	5	96
6	1684	16	70	99	0.1	0	7
7	1795	16	72	98	0.8	2	8
8	1482	46	47	98	0.7	0	13
9	2111	22	69	98	0.4	3	4

Table 2 C: Codling moth sprays; Cortland and Red Delicious, 1945;

Results against wooly apple aphis and the leafminer, Lithocolletes crataegella: Treatments as listed in table 2 A:

Treatment Number:	No. of insects per 100 linear inches of twigs in November, 1945		No. of insects per 100 leaves in October, 1945:	
	Live wooly aphids:	Parasitized wooly aphids:	Leaf miners:	Leaf miner parasites:
1	12	5	68	6
2	6	10	65	12
5	0	0	0	0
6	0	0	0	0
8	6	1	0	0
Commercially sprayed in 2,3,4 covers with materials as in No. 2 followed by 5,6,7 covers of materials as in No. 1	2	4	75	15
Commercially sprayed in 2,3,4 with ½-3-3-100 DDT-Lead arsenate-lime, followed by 5,6,7 covers of materials as in No. 1	116	1	14	0

Table 2 D: Codling moth sprays; Cortland and Red Delicious, 1945:

Carry-over to 1946 of European red mite eggs, Tetranychus mite adults and eggs of the apple aphids other than wooly after treatments as listed in Table 2 A:

Treatment Number:	Number of Tetranychus mites per sq. inch of brushed bark:	Number of eggs per 100 linear inches of 1 and 2 yr. wood:		Relative abundance of overwintering stages: November, 1945		
		European Red Mite:	Apple Aphids:	Tetranychus mites:	E. red mite eggs:	Apple aphid eggs:
1	47	567	1308	1.5	1.0	1.4
2	32	566	946	1.0	1.0	1.0
5	73	835	1306	2.3	1.5	1.4
6	503	1393	1744	15.7	2.5	1.8
8	644	1151	1913	20.1	2.0	2.0

Table 3 A: Codling moth sprays; Stayman, 1945:

	Preliminary sprays* 8 replicates:	Test treatments for heavy hatching of the first brood:	Spray for stragglers of first brood:	Test treatments for heavy hatching of the second brood:
	Petal-fall Apr. 18 Curculio or first cover spray-May 14	2nd cover - May 22 3rd cover -June 2 4th cover -June 14	5th cover- June 26:	6th cover - July 24 7th and final cover- August 10.
Treatment Number:	Covers in which mixtures were used:	Materials and rates per 100 gallons of spray:		
1	2,3,4	Lead arsenate 3 lbs. DDT ½ lb. (SW 50% DDT 1 lb.) DN111-1¼ lbs.		
	5 only	Lead arsenate 4 lbs. ½-2-100 Bordeaux mixture.		
	6 and 7	Lead arsenate 3 lbs. DDT ½ lb. ½-2-100 Bord. mix.		
2	2,3,4	Lead arsenate 3 lbs. DDT ½ lb. Delmo Z 1 lb.		
	5 only	Lead arsenate 4 lbs. ½-2-100 Bordeaux mixture.		
	6 and 7	Phenothiazine 2 lbs. Multifilm 6 oz.		
3	2,3,4	Lead arsenate 3 lbs. Phenothiazine 2 lbs.		
	5 only	Lead arsenate 4 lbs. ½-2-100 Bordeaux mixture.		
	6 and 7	Lead arsenate 3 lbs. Phenothiazine 2 lbs. Multifilm 6 oz. Kerosene 1 qt.		
4	2,3,4	Lead arsenate 3 lbs. Phenothiazine 2 lbs. Fl. sulf. 3 lbs.		
	5 only	Lead arsenate 4 lbs. ½-2-100 Bordeaux mixture.		
	6 and 7	Lead arsenate 3 lbs. Phenothiazine 2 lbs.		
5#	2,3,4,5,6,7	Lead arsenate 4 lbs. ½-2-100 Bordeaux mixture.		

* Each of the first four codling moth treatments were applied to 8 single tree plots arranged in 8 blocks. Of 8 blocks containing 1 tree of each of the 4 treatments, 2 had received petal-fall and first cover sprays of (a) 3# lime, (b) 5# Uramon, (c) 2# Regular grade Frits, (d) 2# Regular grade Frits and 5# Uramon each included with 10 lbs. Camden sulfur paste and 3 lbs. lead arsenate.

No. 5 was a single tree at one end of the block and was sprayed as (a) in petal-fall and first cover. This block was bordered on the North by heavily infested trees where poor control of first brood was obtained with lead arsenate and lime and on the South by a previously heavy infestation that was practically exterminated by Lead arsenate-Phenothiazine in first brood sprays of 1945.

Table 3 B: Codling moth sprays; Stayman, 1945:

Results against codling moth; sprays listed in table 3 A.

Treatment Number:	Total fruits per tree:	Per cent picked fruits:	Per cent clean fruits:	Per cent wormy:	Worm holes per tree: First Brood:	Worm holes per tree: Second Brood:	Total sting and worms per tree:
1	5190	23	96.6	0.5	12	20	217
2	6377	22	96.9	1.0	25	58	270
3	5133	34	94.5	0.9	17	42	417
4	4109	36	93.9	0.9	5	27	312
5	2335	29	60.7	16.7	85	429	1789

Table 4 A: Codling moth sprays; Smokehouse, 1945:

	Preliminary sprays* alike to all trees:	Test treatments for heavy hatching of the first brood:	Spray for stragglers of 1st Br:	Single spray for peak hatching of second brood:
	Petal-fall Apr. 21 Curculio or first cover - May 14	2nd cover- May 24 3rd cover-June 4 4th cover-June 15	5th cover June 27:	6th cover: Aug. 2:

Treatment Number:	Covers in which materials were used:	Materials and rates per 100 gallons of spray:
1	2,3,4,5,6	Lead arsenate 3 lbs. Bordeaux mixture ½-2-100
2	2,3,4,5,6	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
9	2,3,4,5,6	DDT 1 lb. (Deenate 4 lbs.)
5	2,3	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
	4,5,6	DDT 1 lb.
6	2,3	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
	4,5,6	155/DDT 2 lbs. (0.14 lbs. Nicotine, 0.34 lbs. DDT) and Orthol K - 2 qts.
4	2,3	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
	4,5	DDT 1 lb.
	6	Lead arsenate 3 lbs. Phenothiazine 2 lbs. Multifilm 6 oz. and kerosene 1 qt.
3	2,3	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
	4,5	DDT 1 lb.
	6	Lead arsenate 3 lbs. Phenothiazine 2 lbs. Orthex 1 pt.
7	2,3	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
	4,5,6	Phenothiazine 2 lbs. Flotation sulfur 3 lbs. G. Frits 1 lb.
8	2,3	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
	4,5,6	Phenothiazine 2 lbs. Nicotine Dry Conc. 2 lbs. (0.28 lbs. N.)

*- Preliminary sprays as in table 2 A.

Table 4 B: Codling moth sprays; Smokehouse, 1945:

Results against codling moth; sprays listed in table 4 A.

Treatment Number:	Total fruits per tree:	Per cent picked fruits:	Per cent clean fruits:	Per cent wormy:	Worm holes per tree: First Brood:	Worm holes per tree: Second Brood:	Total stings and worms per tree:
1	3849	65	84	9.5	48	360	1161
2	2672	80	95	3.5	3	111	198
9	4546	70	97	0.5	1	24	120
5	4194	71	98	0.7	2	31	62
6	5221	62	91	6.2	40	322	583
4	3310	72	95	3.0	2	88	159
3	3880	62	95	2.2	10	76	189
7	3616	79	92	6.4	19	223	352
8	5119	71	94	5.0	8	262	366

Table 5: Codling moth control and European red mite build-up on light-crop trees sprayed for first brood codling moth. Summer Rambo, 1945:

Materials and rates* per 100 gallons of spray:	Codling moth worm holes per 100 fruits:	European red mites and eggs per 100 leaves: May 14:	June 26:	July 13:	July 30:	Aug. 1
DDT 1 lb. May 24, June 4 and June 15:	0.8	0.4	88	457	2757	8396
DDT 1 lb. Uramon 2 lbs. in comparable sprays:	1.4	0.4	45	309	1537	5334
DDT 1 lb. Uramon 2 lbs. G. Frits 2 lbs. in comparable sprays:	0.9	0.4	19	135	2235	8400
Phenothiazine 2 lbs. and lead arsenate 3 lbs. in comparable sprays plus lead arsenate 3 lbs. and Bordeaux mixture ½-2-100 in an additional spray June 27:	2.1	0.4	10	61	307	916

* A delayed dormant spray of 3% oil was applied to these trees by the grower and excellent early control of mites was obtained. All DDT treatments (2½ lbs. Gesarol AK-40) in this experiment were preceded by a curculio spray of flotation sulfur paste 10 lbs., lime 3 lbs., lead arsenate 3 lbs., on May 14. Lime was omitted from the sprays preceding phenothiazine-lead arsenate. The slow build-up of mites on phenothiazine-lead arsenate sprayed trees as compared to the DDT from May 14 to June 26 was attributed mostly to the activity of the mite predator, Hyaliodes vitripennis. First brood nymphs were then present in numbers of 3 to 5 per 100 leaves [redacted] and entirely absent after May 24 on DDT sprayed trees.

Table 6 A: Codling moth sprays applied by the grower to blocks of 4 x 5 Rome Beauty trees, 1945.

Preliminary sprays* alike to all trees: Petal-Fall Apr. 21. Curculio or first cover - May 14.

Other codling moth spray dates: 2nd cover - May 24, 3rd cover - June 4, 4th cover - June 14, 5th cover - June 26, 6th cover - July 26, 7th cover - Aug. 6.

Treatment Number:	Covers in which materials were used:	Materials and rates per 100 gallons of sprays
4	2,3,4	Lead arsenate 3 lbs. Phenothiazine 2 lbs.
	5 only	Lead arsenate 3 lbs. Bordeaux mixture ½-2-100
	6 and 7	Lead arsenate 3 lbs. Phenothiazine 2 lbs. Orthex 1 pt.
1	2,3,4	Lead arsenate 3 lbs. Phenothiazine 2 lbs. Nic. Dry Conc. 2 lbs.
	5 only	Lead arsenate 3 lbs. Bordeaux mixture ½-2-100
	6 and 7	BL 155 2 lbs. Orthol K-2 qts.
2	2,	Lead arsenate 3 lbs. Dry Conc./DDT 2 lbs.
	3,	Dry Conc./DDT 2 lbs.
	4,	Dry Conc./DDT 2 lbs., Bord. mixture ½-2-100, Orthol K-2 qts.
	5,6,7	Dry Conc./DDT 2 lbs., Orthol K-2 qts.
3	2,	Lead arsenate 3 lbs. BL 155/DDT 2 lbs.
	3,	BL 155/DDT 2 lbs.
	4,	BL 155/DDT 2 lbs., Bord. mix. ½-2-100, Orthol K-2 qts.
	5,6,7	BL 155/DDT 2 lbs. Orthol K-2 qts.

* Preliminary sprays at petal-fall and first cover consisted of flotation sulfur paste 12 lbs. and lead arsenate 3 lbs.

Table 6 B: Codling moth sprays; Rome Beauty, 1945.

Results against codling moth; Sprays listed in table 6 A.

Treatment Number:	Total fruits per tree:	Per cent picked:	Per cent clean:	Per cent wormy:	Worm holes per tree: First Brood:	Worm holes per tree: Second Brood:
4	2381	84	89	2.6	15	51
1	1252	70	86	6.9	7	95
2	1968	67	78	9.3	61	162
3	1702	70	70	15.3	91	173

VIRGINIA

W. J. Schoene, Virginia Agricultural Experiment Station, Blacksburg.

Results on codling moth of two tests in which DDT was used primarily against Comstock's mealybug follow.

Experiment 1 - Troutville, Va.

Fruit examined July 18. Sprays applied on top of regular orchard program that included 6 lead covers and 2 with oil.	No. Applications	Stings per 100 Apples	Worms per 100 Apples
3/4 lb. DDT	2	58	20
3/4 lb. DDT	4	48	10
1 1/2 lb. DDT	2	53	6
1 1/2 lb. DDT	4	45	8
1/2 pt. BL 40 + 1/3 lb. DDT	4	66	14
1/2 pt. Loro - 1 gal. Kerosene	4	68	26
Check 1/		104	38

1/ It should be remembered that the trees labeled check above received regular orchard treatments of 6 lead covers 2 of which contained oil.

The apples on the trees receiving 4 applications of DDT, 1 1/2 pounds looked very much better than any of the others treated. The stings on these apples were very small whereas the stings on the other apples are mostly of good size.

Sprays containing DDT timed for mealybug and applied April 19 and 30, and June 21 and 28.

Some injury by mites in DDT plots.

DDT in Andrews Orchard - Hollins, Va.

Sprays applied on top of regular program including 8 arsenate of lead sprays and timed for mealybug control. 1/	Records July 17 Stings per 100 Apples	Worms per 100 Apples
1 tree DDT 2/ 1 pound to 100 gallons 4 covers	7	0
7 trees DDT 1 pound to 100 gallons 5 covers	12	2
8 trees DDT 1/2 pound to 100 gal. combined as follows: First spray - 1/2 pt. BL-40 (lime) Second spray - 1 1/2 lb. lead arsenate Third, Fourth, Fifth spray - BL-155 3/	12	6/8
Check near sprayed trees 4/	28	10
Infestation in south central part of orchard	199	190

1/ Sprays containing DDT applied May 8, May 23, May 31, June 22, and July 28.

2/ DDT used was DuPont's 25% water dispersible powder.

3/ For the last two sprays experimental lots of DDT and BL 155 were supplied by the Black Leaf 40 Company. This was used at the rate of 3 pounds per 100 gallons and contained 7 percent nicotine and 17 percent DDT.

4/ Received regular program including 8 lead arsenate sprays.

VIRGINIA (Continued)

A. M. Woodside, Field Laboratory, Virginia Agricultural Experiment Station, Staunton.

The carry-over of codling moths in the spring of 1945 was the heaviest ever noted in Augusta and Albemarle Counties. Emergence started considerably earlier than normal, but cool weather prevented the moths emerging in April from depositing many eggs. Weather after the middle of May was generally favorable to the codling moth, as the temperatures were generally at or above normal, and the precipitation, except for a brief period in July, below normal. The apple crop was very light, which made it doubly difficult to protect. The percent of fruit injured was very high wherever there was any crop. The prospective carry-over is not high, however, except in a few orchards where there was near a normal crop.

DDT was used in some small-scale experiments, and was very satisfactory. Mite infestations increased greatly wherever it was used, and in all orchards in which examinations were made following its use. Evidently additional materials for the control of mites must be added whenever DDT is used in this area.

VIRGINIA (Continued)

W. S. Hough, Winchester Research Laboratory, Virginia Agricultural Experiment Station, Winchester.

The season of 1945 was not especially favorable for codling moth development. Precipitation from June to August inclusive was two times the normal rainfall.

DDT was used in powder formulations only and all references to dosage indicate the amount of the prepared formulation used. The 25 percent DDT formulation came from the DuPont Company, AK-40 and AKZ-40 from the Geigy Company, and the 50 percent DDT was prepared by Dr. E. D. Witman, Ohio State University Research Foundation. Genicide-DDT mix (used in plot 40) came from the General Chemical Company and contained 25 percent DDT and 50 percent xanthone according to the manufacturer's statement.

In orchard tests (mostly on York Imperial variety) no evidence of incompatibility or injury was observed when DDT in powder formulations was used with the following spray ingredients: sulfur, lime, zinc sulfate and lime, Bordeaux mixture, lead arsenate, DN-111, DN-Dry Mix No. 1, Genicide, mineral oil, or fish oil.

Tests on fruit sprayed at the laboratory as well as on orchard sprayed fruit indicated that mineral oil (83 percent emulsion 3 quarts or Orthol-D oil at 6 quarts per 100 gallons) decreased initial toxicity of the DDT spray to larvae and did not prolong the period of effective control.

In late August mites were approximately seven times more numerous on trees sprayed with DDT as compared with adjoining lead arsenate treatments. However, the infestation did not build up in time or in sufficient numbers to result in severe bronzing of the foliage as occurred in 1944. Mites were just as numerous on trees sprayed through the season with 1 pound of 25 percent DDT per 100 gallons of spray as with 4 pounds of 25 percent DDT. Two species of mites are involved, the European red mite and the apple mite (Tetranychus schoenei McG.).

Several preparations intended to reduce or suppress mite development were used in certain DDT applications usually beginning in the third cover spray, but in all instances included in the last DDT spray applied in the plot. A summary of the results as observed at the end of August and compared with lead arsenate and DDT alone is as follows:

Plot No.	Preparation and Amount per 100 gallons	Cover Sprays	Mites per 100 Leaves
39	DN-Dry Mix No. 1, 2/3 lb.	5,7,8	19
31	DN-Dry Mix No. 1, 2/3 lb.	5,6,7,8	73
40	DDT-Genicide Mix 2 lb.	3,4,5,6,7,8	134
33	DN-111, 1 1/4 lb.	3,5,7	143
29	C-336, 1 1/4 lb.	3,5,7	243
	Lead arsenate		369
34	C-336, 1 1/4 lb.	3,5,7	384
30	Genicide 1 lb.	3,5,7,8	641
35	Genicide 1 lb.	3,5,7	708
36	Orthol-K oil 3 qt.	3,4,5,6,7	1023
	DDT at various dilutions, average		2865
	infestation range		2488 to 3369

DDT residues were determined by the Division of Chemistry, Virginia State Department of Agriculture, and also by the Geigy Company. Both organizations used the Gunther method. In most instances fruit carrying a DDT residue of .06 gr./lb. or higher was not cleaned to the informal tolerance of .05 gr./lb. when washed for 45 seconds by any of the following treatments: sodium silicate 75 pounds per 100 gallons alone or with soap or in tandem washing, i.e., sodium silicate followed by HCL 1 1/2 percent or vice versa; Mermaid soap or Octagon laundry soap at 4 pounds and 10 pounds per 100 gallons; IN-181-P 2 ounces; also brushing in commercial brushing or polishing machines likewise failed to clean the fruit to the informal tolerance.

Results of orchard tests on codling moth control are summarized in Table 1 showing percentage of fruits grading "wormy" and percentage showing visible injuries "stings" or "worms" including all drops collected from early July to harvest time in September. Dates of cover sprays were as follows: First cover, April 30 to May 1; second cover, May 15-16; third cover, May 29-30; fourth cover, June 12-13; fifth cover, June 25-26; sixth cover, July 23-24; seventh cover, August 6-7; eighth cover, August 17-18.

Table I. Results of orchard tests, Winchester, Va.

Note: Lead arsenate 3 pounds in calyx spray, also in first cover in certain plots where DDT was not used until the second cover.

Plot No.	Cover Sprays	Materials per 100 gallons (#-lbs.)	Percent Wormy	Percent Injured	DDT Residue gr./lb.
Cather orchard, York Imperial variety					
9	1-8	Lead 2#	5.61	32.57	
	1-8	Lead 3# (Avg. 23 plots)	3.91	28.26	
10	1-8	Lead 4#	1.85	18.15	
27	1-8	AKZ-40 2#, Gesafloc ½ pt.	0.17	4.08	
28	1-8	AKZ-40 2½#, Gesafloc ½ pt.	0.48	3.30	.067
29	1-8 3,5,7,8	AKZ-40 2½#, Gesafloc ½ pt. (C-336) 1¼#*	0.16	3.41	.086
30	1-8 3,5,7,8	AKZ-40 2½#, Gesafloc ½ pt. Genicide 1#	0.90	4.37	.087
31	1-8 5-8	25% DDT 4# DN-Dry Mix 2/3#	0.10	2.75	
32	2-7	25% DDT 4#	0.06	2.36	.058
33	2-7 3,5,7	25% DDT 4# (DN-111) 1¼#	0.26	4.40	
34	2-7 3,5,7	25% DDT 4# (C-336) 1¼#*	0.40	4.01	.075
35	2-7 3,5,7	25% DDT 4# Genicide 1#	0.22	1.70	
36	2-7 3-7	25% DDT 4# Orthol-K oil 3 qts.	0.49	3.83	.129
37	2,4,6,7 7	25% DDT 4# DN-Dry Mix 2/3#	2.28	7.50	
38	1-8	25% DDT 1#, lead 3#	0.28	12.15	.041
39	1-8 5,7,8	25% DDT 2#, lead 3# DN-Dry Mix 2/3#	0.28	4.89	.047
40	1-2 3-8	Lead 3#, lime 2# Genicide-DDT mix 2#	9.02	17.86	.011
		Checks, unsprayed	96.61	97.94	
Vinegar Company orchard, York Imperial variety					
	1-8	Lead 3# (Avg. 3 plots)	1.50	17.74	
5	2-7	AK-40 1¼#	0.33	4.19	.037
6	2-7	AK-40 2½#	0.10	0.70	.074
7	2-7 4-7	AK-40 2½# Orthol-D oil 6 qts.	0.09	1.30	.179
		Checks, unsprayed	83.07	86.69	
Vinegar Company orchard, Stayman variety					
	1-8	Lead 3# (Avg. 2 plots)	4.32	24.74	
14	2-8	50% DDT 2#	1.39	5.95	.044
15	1-8	50% DDT 12 oz., lead 3#	4.92	14.78	.038
		Checks, unsprayed	94.12	96.43	

*C-336 same as DN-111 but contained less wetting agent.

WASHINGTON

W. J. O'Neill and K. C. Walker, Tree Fruits Branch, Wenatchee and R. L. Webster, Washington Agricultural Experiment Station, Pullman.

I. Seasonal Conditions and Status of Codling Moth Infestation 1945.

The winter months of 1944, and 1945 were favorable to survival of hibernating codling moth larvae. Average monthly temperatures were above normal with minimum monthly temperatures recorded as follows: December 24, 5°; January 21, 16°; February 19, 20°; March 5, 16°; April 6, 28°; May 17, 38°.

Six bait traps were placed in the orchard May 2 and found to contain twelve codling moths next morning. Moths captured in bait traps on nights of May 2, 3, and 4, all proved to be males. Females were first taken on the night of May 5. The highest sustained spring brood moth catch occurred May 28 to June 2. Considerable variation occurred in the nightly catches of first brood moths but the period extending from July 23 to August 9 gave consistently high catches. Cool weather prevailed during May and June, which resulted in a long drawn out emergence period with no sharp interval between spring brood and first brood moths. Late summer and fall weather was warm and dry favoring late activity which continued into October.

Results of Control Experiments

Spray materials/100 gallons

Plot No.	materials/100 gallons
1.	Cond. cryolite (1*) 3 lbs., Lt. oil (Si-234) (2*) 1 qt. 1, 5, 6, & 8th covers; 2 qts. 2, 3, 4, & 7th.
2.	HE-761 (3*) 1½ lbs., 5 covers.
3.	HE-761 1½ lbs., 8 covers.
4.	Flot. cryolite (4*) 3 lbs., Lt. oil (Si-234) 1 qt., 1, 5, 6, and 8th covers, 2 qts. 2, 3, 4, and 7.
5.	AKZ(5*) 1-lb. Gesafloc ½ pt. 1, 2, 3, 4, & 5th covers. AKZ 1 lb. DN-111 (7*) 5 ozs., 6, 7, & 8th covers.
6.	AKZ 1 lb., Gesafloc (6) ½ pt., 8 covers.
7.	Cryolite (8*) 3 lbs., 214 R (9*) 1½ pts., 8 covers.
8.	AKZ, ½ lb., Gesafloc ½ pt., 1, 2, 3, 4, & 5th covers. AKZ, ½ lb., DN-111, 5 ozs., 6, 7, covers.
9.	AKZ, ½ lb., Gesafloc, ½ pt., 8 covers.
10.	L. A.(10*) 3 lbs., Lt. oil (11*)1 qt., 1 & 5 covers, 2 qts. 2,3,4, & 7.
11.	Cryolite 3 lbs. Lt oil (11*) 1 qt., 1 & 5 covers, 2 qts., 2, 3, 4 cover Cryolite 3 lbs. Oil-Thanite(12*) 1 qt. 6 cover 2 qts 7th & 8th.
12.	Cryolite 3 lbs. Lt oil (11*) 1 qt. 1, 5, 6, & 8 covers; 2 qts. 2, 3, 4 & 7.
13.	L.A. 3 lbs. Lt. oil (13*) 1 qt. 1, 5, 6, & 8 covs. 2 qts. 2,3,4, & 7.
14.	Cryolite 3 lbs., Lt. oil (13*) 1 qt., 1, 5, 6, & 8th covers; 2 qts., 2, 3, 4, & 7th.
15.	L.A. 3 lbs. Lt. oil (2*) 1 qt., 1,5,6, & 8th covers; 2 qts 2,3,4, & 7/
16.	Cryolite 3 lbs., Lt. oil (2*) 1 qt., 1, 5, 6, & 8th covers; 2 qts., 2, 3, 4, & 7th.
17.	L.A. 3 lbs., Lt. oil (11*) 1 qt., 1 & 5th covers; 2 qts., 2, 3, & 4th. L.A. 3 lbs., oil Thanite (14*) 1 qt., 6th cover; 2 2ts., 7 & 8th.
18.	L.A. 3 lbs., Lt. oil (11*) 1 qt., 1 & 5th covers; 2 qts., 2, 3, & 4th. L.A. 3 lbs., 314 R, 1½ qt. 6th cover; L. A. 3 lbs., Isothan Q, (15*) 1 pt., 7th., Isothan Q ½ pt., 8th cover.
19.	L.A. 3 lbs., Lt. oil (11*) 1 qt., 1st cover; L.A. 3 lbs., Lt. oil 2 qts., 2nd cover. Genicide (16*) 2 lbs., Kerosene (Cas. Am) 1 qt., 3, 4, 5 & 6th covers. Genicide 2 lbs., Isothan Q, 1 pt., 7 cover; Isothan Q ½ pt., 8th cover.
20.	L.A. 3 lb. Lt oil (17*) 1 qt., 1, 5, 6 & 8th covers; 2 qts 2,3,4, & 7.
21.	Cryolite 3 lbs., Lt. oil (17*) 1 qt., 1, 5, 6, & 8th covers., 2 qts., 2, 3, 4, & 7th covers.
22.	AK40 (18*) 1 lb. 8 covers.
23.	AK40 1 lb. 1,2,3,4, & 5th covers. AK40 1 lb. DN-111 5 ozs. 6,7, & 8 covers.

Plot No.	materials/100 gallons
24.	L. A. 3 lbs., 314 R. 1½ pts., 8 covers.
25.	AK40, ½ lb., 8 covers.
26.	AK40, ½ lb., 1,2,3,4, & 5th covers; AK40, ½ lb., DN-111, 5 ozs 6, 7.
27.	L. A. 3 lbs., oil-thanite (14*) 1 qt., 1, 2, 3, 4, 5, 6, & 8th covers; 2 qts., 7th cover.
28.	B. L. -40-DDT, (19*) 3 lbs., Lt. oil (13*) 1 qt., 1, 5, 6, & 8th covers; 2 qts., 2, 3, 4, & 7th covers.

Note: Cover spray applied 5/22 6/2-6/12 6/23 7/5 7/18 8/4 8/18respectively

SPRAY MATERIALS.

(1*) Cond. cryolite, a specially processed m'tl. 90% sodium fluoaluminate, Penn Salt Co.

(2*) Si-234; Lt. oil containing 1/28 fish oil soap, Sherwin Williams Co.

(3*) H. E. 761; organic material, Rohm & Haas Co.

(4*) Flotation cryolite, refined natural cryolite, 98% sodium fluoaluminate; Penn. Salt Co.

(5*) AKZ, Pyrophillite-DDT (40% DDT) Geigy Inc.,

(6*) Spreader, Zn-K fish oil soap. Geigy Co.

(7*) DN-111, 20% amine salt of DNOCHP, Dow Chem. Co.

(8*) Cryolite, 90% sodium fluoaluminate, Penn. Salt Co.

(9*) 314 R, rotenone extractives, Am. Cyanimid Co.

(10*) L. A. lead arsenate, Corona Chem. Co.

(11*) Lt. oil, Avon 2060, Tidewater Associated Oil Co.

(12*) Oil-Thanite, Avon 2060+ Thanite at 100 ml. per gal., Hercules Powder Co.

(13*) Lt. oil, Summer mulsion Lt. Flowable, Sherwin Williams Co.

(14*) Oil-Thanite, Avon 2060 + Thanite at 25 ml. per gal.

(15*) Isothan Q., Dichloronaphthoquinone-Onyx oil Co.

(16*) Genicide, Xanthone, Genreal Chemical Co.

(17*) Lt. oil, Porable 90-Si 208; Sherwin Williams Co.

(18*) AK40, pyrophillite - DDT (40% DDT) Geigy Co.

(19*) B. L. 40-DDT, 7% nicotine, 17% DDT, Bentonite, Tabacco By-Products, & Chem. Corp.

Plot Arrangement & (% Wormy)

Trees	Rows 36	35	34	33	32*
14	26(48)		27(70)		x
15		27(54)		28(10)	
16	26(36)		28(7)		x
17		24(13)			
18	25(31)				x
19		24(35)		23(3)	
20	25(26)		22(1)		
21		21(24)		23(2)	
22	21(49)		22(6)		x
23		20(15)		18(67)	
24	20(32)		19(49)		x
25					
26	16(64)		19(37)		x
27		16(35)		18(75)	
28	15(69)		17(62)		x
29		15(52)		17(32)	
30					x
31		14(36)			
32	14(49)		12(22)		
33				11(28)	
34	13(63)		12(47)		x
35		13(36)		11(37)	
36					x
37		9(12)		10(42)	
38	8(7)		9(8)		x
39		8(18)		10(20)	
40	7(41)		5(2)		x
41				4(33)	
42	7(35)				x
43		6(0)		4(15)	
44					x
45		6(0.5)		3(4)	
46			2(13)		x
47					
48	1(50)		2(11)		x
49		1(38)		3(4)	
50					x

* Buffer row.

Plot Nos are given with % wormy in ( ).

Plot No.	Avg. box prod.	% wormy	% clean	w/100	Mite damage 1/ 8/7 8/20	10/5	mmg/cm2 6cover Deposit of insecticide	materials
1	15	44	14	75	2-1	0-1	102.5	Cond.Cry-Si-234
2	11	12	41	18	4-4+	4		HE-761 5 covers
3	13	4	54	5	4-4+	4		HE-761 8 "
4	20	24	31	39	2-3	3-4	143.9	Flot Cry-Si-234
5	33	2.5	84.5	2.5	2-0	2		AKZ 1# SP. +DN 111
6	22	0.25	91	0.25	3-3	4		AKZ 1# SP.
7	19	38	26	58	2-0	0-1	117.4	Cry-314R
8	28	13	61	17	2-0	2-3		AKZ ½# SP. DN 111
9	26	10	55	16	2-3	3-4		AKZ 1# SP.
10	20	31	24	68	2-2	2-3	29.8	L.A.Avon 2060
11	26	33	23	53	2-3	1-3	28.1 2/	L.A.Avon + Than.
12	22	35	20	61	2-2	2-3	117.8	Cry + Avon 2060
13	20	50	32	140	2-2	3-2	31.2	L.A.-S.M.L.F.
14	19	43	28	68	2-3	2-1	111.8	Cry-S.M.L.F.
15	20	61	11	156	2-2	1-3	26.6	L.A. Si-234
16	23	50	13	107	2-1	0-1	94. 0	Cry-Si-234
17	17	47	25	131	2-2	2-3	23.6 2/	L.A. Avon-Than.
18	10	71	12	282	2-1	2-3		L.A. Isothan Q
19	18	43	32	92	2-1	1-3		Gen.
20	26	23	45	45	2-2	2-3	28.8	L.A. Si-208
21	23	37	32	60	2-1	0-1	81.9	Cry. Si-208
22	27	3.5	75	4	2-3	3-4		AK40#
23	27	2.7	81	4	2-0	1		AK1# DN
24	15	24	39	47	2-0	0-1		L.A. 314R
25	19	29	47	45	2-3	3-4		AK40 ½#
26	15	42	29	86	2-0	1		AK40 ½# DN 111
27	8	62	14	184	2-2	1-2		L.A. Than
28	12	58	58	13	3-4	3-4		Nicotine DDT oil

1/ figures under 8/7 + 8/20 indicate relative abundance of mites by visual inspection whereas 10/5 indicates foliage injury at harvest time.

2/ 4th cover spray.

18. SUMMARY

1. DDT at 0.4 lb (plots 5, 6, 22 and 23) resulted in excellent codling moth control.

2. DDT at 0.2 lb (plots 8, 9, 25, and 26 were consistently less effective than 0.4 lb. DDT but compared favorably with the rest of the plots.

3. DDT nicotine bentonite oil resulted in severe worm damage.

4. All DDT sprayed plots were severely damaged by Pacific mites unless DN 111 was added, wooly apple aphid infestations increase was also noted.

5. DDT-DN 111 combinations show promising control of both codling moth and Pacific mites.

6. HE-761 gave promise as a codling moth control but was severely infested with Pacific mites.

7. Comparison of codling moth or mite control on the remainder of the plots is of questionable value because of lack of replication.

CANADA (British Columbia)

Jas. Marshall, Dominion Entomological Laboratory. Summerland, British Columbia.

SCOPE OF INVESTIGATIONS AND EXPERIMENTAL PROCEDURE

1. Trunk Sprays

Four orchards, 12 acres, approximately 1 acre plots except for 2 acres of hand pump experiments. Dormant application to a height of 8 feet. Dosage: about 2 Imperial gallons per tree capable of bearing 40 boxes. Pressure 150 pounds. Disc aperture -5/64.

2. Summer Sprays

Two orchards, 6 acres, 6 or 8 tree plots, generally duplicated. Check plots immediately adjoined each experimental plot. One orchard four cover sprays, the other, five. Dosage: about 1 Imperial gallon per box of maximum crop per application. Checking: 500 apples per tree including dropped fruit, random sampled. Variety: McIntosh. Residue determinations not yet available.

RESULTS OF TRUNK SPRAY APPLICATIONS

1. Fifteen gallons distillate oil (38 S.S.U. Vis. 100°F.) and 7 pounds 40% dinitro-o-cresol per 100 gallons. Noticeably less effective than 20 gallons distillate with same amount dinitrocresol.

2. Importance of type and quantity of emulsifier has been emphasized in both experimental and commercial applications. When quantity of sodium lauryl sulfate emulsifier increased from 1.25 pounds to 2.5 pounds per 100 gallons and used as paste (DUPONOL W.A.) instead of powder, mortality of larvae decreased from about 80% to 30%. (Trunk spray emulsions evidently should have minimum stability.)

3. Addition of oleic acid 5%, appeared to increase considerably effectiveness of distillate-dinitrocresol mixture.

4. Ten different petroleum fractions have been applied for four successive years at 100% concentration to same apple tree trunks. Lightest fraction (stove oil, 32. S.S.U. Vis. 100°F.) has been most injurious; heaviest fraction (dormant oil 220 S.S.U. Vis. 100 F.) least injurious. All trees that received stove oil now dead but those that received heavy dormant oil show little injury. Solution of 2% dinitrocresol in petroleum has slightly increased injury, 4% definitely.

RESULTS OF SUMMER SPRAY APPLICATIONS:

Table I

DDT spray Mixtures and Infestations at Harvest
(Experimental Plots should be compared with adjoining check plots)

Materials per 100 imp.gal.	Plot	% Stung	% Wormy By plots	% Wormy Mean
Orchard A				
Check Cryolite 4 lb. Casein 0.5 oz., Lime 4 oz.,	14 23	8.6 8.1	25.8 31.8	28.8
DDT Tech: 0.25 lb. Acetone 1 pt. Casein 2 oz. Ammonia 28% 0.4 oz.	15 24	5.5 4.0	57.3 68.4	62.8
Same but with added dicyclohexylamine salt of dinitrocyclohexylphenol 5 oz. (DN 111"1.5 lb.)	16 25	3.1 3.8	51.4 63.9	57.6
Check Cf. plot 14.	17 26	8.3 11.2	25.3 41.9	33.3
DDT Tech. 0.25 lb. VELSICOL A.R. 60 0.5 pt. Stove oil (32 S.S.U. Vis. 100°F.) 0.5 gal. Sodium lauryl sulphate 20% 4 oz. (DUPONOL W.A. PASTE)	18 27	5.3 9.4	40.9 44.8	42.8
Same but summer oil (65 S.S.U. Vis. 100°F., 75% U.R.) substituted for stove oil.	19 28	6.3 8.2	38.6 33.0	35.8
Check Cf. plot 14.	20 26	7.5 11.2	34.5 41.9	38.2
Orchard B				
DDT 17%, Nicotine 7% 3 lb. (Proprietary"B.L. 155" formulation)	1	3.8	2.1	
Check Cryolite (natural) 4 lb. Bunker oil (65 S.S.U. Vis. 100°F.) 1 pt. Monoethanolamine oleate 1 oz.	2	13.6	8.4	
DDT 20% (GESAROL A.K. 20) 2.5 lb.	6	6.0	2.3	
Check Cf. plot 2.	5	17.3	12.6	

Table II

Lead Arsenate & Cryolite Spray Mixtures & Infestations at Harvest.

Materials per 100 imp. gal.	Plot	% Stung	% Wormy
Lead arsenate 4 lb. Casein 0.5 oz. Lime 4 oz.	7	7.7	36.7
Cryolite (Canadian micronized) 4 lb. Casein 0.5 oz. Lime 4 oz.	8 (adjoining 7)	5.7	22.9
Same but added ammonium salt of dinitrocyclohexylphenol 5 oz.	9	3.9	17.0
Same but added dicyclohexylamine salt of dinitrocyclohexylphenol 5 oz. ("DN 111" 1.5 lb.)	10	4.1	22.4
Check Cryolite (natural) 4 lb. Casein 0.5 oz. Lime 4 oz.	11	5.7	18.2

Table III

Nicotine Spray Mixtures and Infestations at Harvest

Orchard A

Materials per 100 imp. gal.	Plot	% Stung	% Wormy By plots	% Wormy Mean
Bentonite (Mississippi FILTROL X110) 4 lb. Nicotine sulphate 40% 9.5 oz. Summer oil (65 S.S.U. Vis. 75% U.R.) 0.5 gal. Monoethanolamine- tall oil soap 0.25 lb.	12 21	3.5 4.0	25.1 36.2	30.8
Check Cf. Table I, plot 14.	11 20	5.7 7.6	18.2 34.5	26.3
Same as plots 12 and 21 but residual petroleum i.e., bunker oil (100 S.S.U. Vis. 100° F.,5% U.R. A.O.A.C.) in place of summer oil.	13 22	2.2 4.7	18.7 29.8	24.2
Check Cf. Table I, plot 14.	14 23	8.6 8.1	25.8 31.8	28.8

(Table III continued)	Plot	% Stung	% Wormy By Plots Mean
Nicotinyl zinc fluosilicate 25% - bentonite 75% -- 3 lb. Summer oil (65 S.S.U. Vis. 100°F., 75% U.R.) 0.5 gal. Monoethanolamine-tall oil soap 0.25 lb.	29	4.3	36.2
Check Cf. Table I, plot 14.	26	11.2	41.9

Orchard B

Bentonite (Mississippi, FILTROL X110) 4 lb. Nicotine sulphate 40% 9.5 oz. Residual petroleum, bunker oil (65 S.S.U. Vis.100°F., 5% U.R. A.O.A.C.) 0.5 gal. Monoethanolamine-tall oil soap 0.25 lb.	3	7.4	17.2
Check Cryolite (Natural) 4 lb. Bunker oil (65 S.S.U. Vis.) 1 pt. Monoethanolamine oleate 1 oz.	2	13.6	8.4

Table IV

Xanthone Spray Mixture and Infestation at Harvest

Materials per 100 imp. gal.	Plot	% Stung	% Wormy
Xanthone (GENICIDE)* 2 lb. Stove oil (32 S.S.U. Vis. 100°F.) 1 qt. Monoethanolamine oleate 0.25 lb. Zinc sulphate (23% Zn.) 1.5 oz.	4	8.8	9.4
Check Cryolite (Natural) 4 lb. Bunker oil (65 S.S.U. Vis.100°F.) 1 pt. Monoethanolamine oleate 1 oz.	5	17.3	12.6

* Last 3 covers only; first 2, cryolite 4 lb., casein-lime 2.5 oz.

EFFECTS OF SPRAY MIXTURES ON ORCHARD MITES.

1. DDT - Most formulations caused marked increase in infestations of Pacific mite (Tetranychus pacificus McG.), less pronounced increase in infestations of European red mite. Greatest increase occurred with spray mixtures that contained greatest amount of DDT (GESAROL A.K. 20 at 0.5 lb. DDT equivalent and DDT-BLACK LEAF 155 mixture at similar DDT concentration).

Foliage of McIntosh trees that received five such applications virtually ruined by Pacific mite by end of August and over 50% of crop lost from small size, poor colour, prematurely dropped fruit. Addition of summer oil 0.5 gal. to DDT resulted in fewer mites and fairly satisfactory foliage condition.

2. DDT- Dicyclohexylamine salt of Dinitrocyclohexylphenol (DN 111). Where "DN 111" used with DDT in all applications at 5 oz. active ingredient per 100 imp. gal. foliage not measurably affected by either Pacific mite or European red mite.

3. Xanthone, GENICIDE at 2 lb. per 100 imp. gal. in last 3 cover sprays produced excellent foliage practically free of both species of mites and excellent fruit.

SPRAY INJURY

1) An unusual type of foliage "scorch" occurred when Pacific mite became numerous on DDT plots. This injury more pronounced than anything heretofore associated with mite attack.

2) Only slight yellowing of primary leaves attributable to their being sprayed throughout the season with DDT-summer oil. No sign of injury where DDT used at twice the concentration (0.5 lb.) without oil.

3) No injury observed from four applications residual petroleum (bunker oil) 100 S.S.U. Vis., at 0.5 gal., nor from five applications residual petroleum 65 S.S.U. Vis. at 0.5 gal. Resultant fixed nicotine spray deposit from the more viscous oil, however, somewhat sticky, dark brown in colour and difficult to remove by wiping. No residue difficulty from 65 S.S.U. Vis. bunker oil.

4) No foliage or fruit injury observed from 4 applications nicotinyl zinc fluosilicate 25%, 3 lb. and summer oil (65 S.S.U. Vis., 75% U.R.) 0.5 gal.

CANADA, (Ontario)
W. G. Garlick, T. Armstrong and W. L. Putman, Dominion Entomological Laboratory, Vineland Station, Ontario.

I. Seasonal Conditions and Status of Codling Moth Infestations During 1945

In the areas most subject to codling moth injury there was an extremely light and patchy apple crop, and the pear crop was almost a complete failure. A small carry-over from 1944 gave rise to moths which began emerging ten days later than the previous season. Cool and wet weather slowed up development and the first generation moths did not show up until the second week in August. The per cent of first generation larvae transforming was the lowest in five years, nearly 50% below that of 1944 which was the lowest previously in the five years. In general good spraying gave good control but in any case there was a ready market for almost any kind of apple.

II. Studies on Codling Moth Biology or Behaviour

Biennial Habit - Larvae, collected in 1943, that did not give rise to moths in 1944, yielded 21 moths in 1945. These moths emerged over a 20 day period and were comparatively earlier than 1944 collected material. It is of interest to note that from the original larvae collected in 1943 a single moth emerged on September 5, 1944.

Codling Moth on Pears - In a local pear orchard moths emerging from overwintering larvae appeared two to three weeks later than those in a comparable apple orchard. The appearance of fruit injury in pears during August, previously considered to be due to the second brood, was in reality caused by the late emerging first brood of moths.

III. Results of Control Experiments

Orchard Tests

All amounts of materials are given for 100 Imperial gal. (120 U.S. gal.) DDT used - Geigy, Gesarol AK-20 or AK-40. Quantities used are stated as amounts of actual DDT.

Orchard A

Consisted of 90 mature trees (McIntosh and Spy) and received 3 covers of lead arsenate 3¾ lb. plus 1% summer oil in second and third. Half the orchard (the wormier section in 1944) received in addition 4 oz. DDT. There was practically no crop so all harvested apples were counted.

	No. Apples	% Clean	% Deep	% Stings
McIntosh, no DDT	2183	65.6	9.4	25.0
" 4 oz. DDT	1080	73.9	8.1	18.0
Spy, no DDT	1865	40.0	26.8	33.2
" 4 oz. DDT	1800	65.6	16.4	18.0

Orchard B

This small orchard of mixed varieties was divided into plots 1, 2, 3 and 4. Plot 4, consisting of half the orchard, received no codling moth sprays. Plot 3 adjoined plot 4 and was therefore subject to an overflow of moths from plot 4. Owing to a serious scab situation plots 1 to 3 received COCS 2 lb. and lime 2 lb. in covers one to three, and COCS 1 lb. and lime 1 lb. in fourth cover. Spray dates of covers were June 6 and 23, July 6 and 20. Frequent heavy rains prevailed.

Plot 1 - Lead arsenate 2 lb., DDT 4 oz. in all four covers, plus 1% summer oil in covers two to four.
Plot 2 - DDT 1 lb. in all four covers.
Plot 3 - DDT 8 oz. in all four covers, plus summer oil 1% in covers two to four.
Plot 4 - Check, no codling moth sprays.

Results given below were taken from three Ontario trees per plot, and include all drops.

Plot	No. Apples	% Clean	% Deep	% Stings
1	4148	69.4	17.0	13.6
2	5615	65.7	19.9	14.4
3	4278	74.9	15.1	10.0
4	7260	13.2	66.6	20.2

Orchard C

Two plots were set up in a large commercial orchard where the codling moth has been generally satisfactorily handled by the regular recommendations of oil and lead arsenate. A fixed copper (COCS) fungicide was used.

Plot 3 - Covers one and three, DDT 1 lb., covers two and four lead arsenate 3¾ lb. summer oil 1%. Grower sprayed, supervised.
Plot 4 - DDT 8 oz. in all four covers, plus summer oil 1% in covers two to four. Grower sprayed, supervised.
Plot 5 - An oil and lead arsenate schedule. Grower sprayed, not supervised.

Spray dates - June 7, 19, 28, and July 9.

The harvested crop of four McIntosh trees per plot was examined.

Plot	No. Apples	% Clean	% Deep	% Stings
3	4815	85.9	7.4	6.7
4	5570	91.8	4.6	3.6
5	4271	61.9	14.8	23.3

Notes on other effects from DDT

European red mite - was not a factor in any orchard this season.

Injury - none apparent in any plot in any orchard, either to foliage or fruit.

Residue - two analysed samples from orchard B, plot 2 gave average DDT residue on fruit 2.6 p.p.m. There was a rainfall of 13.82 in. between the last cover and harvest, and 6.57 in. fell in the period first cover to fourth cover, a total in the whole period of 20.39 in.

Effect on honey bees - a single hive of bees remained under one of the trees in plot 2, orchard B, all season. On July 20, at time of fourth cover the flowering, buckwheat cover crop was sprayed over a fairly wide area with DDT 1 lb. in 100 gal. in addition to drip etc. from the regular sprayings. Again in early August an area of approximately 1000 sq. ft. round the hive was sprayed with the same mixture. Not more than five or six dead bees at a time were ever noted in front of the hive. The colony remained strong all season, no injury to brood was detected, and a good yield of honey (with high percentage of buckwheat) was obtained from the colony.

Laboratory Tests

DDT and Hexachlorocyclohexane (666) against newly hatched larvae.

Methods - Procedure was essentially the same as that described in last year's report, Part 1, p. 109. Wealthy apples were used throughout. A check lot of ten fruits, run along with each day's tests, was used as a basis for calculating the efficiency of the sprays according to Abbott's formula.

A. Tests with Hexachlorocyclohexane (666)

Hexachlorocyclohexane, also known as benzene hexachloride or 666, was tested in comparison with DDT (aerosol grade, 99% para-para isomer). The materials used were the pure gamma isomer of 666, and crude 666 containing approximately 10-12% gamma isomer, both being obtained from Imperial Chemical Industries, England. They were ground for 15 hours in a ball mill along with pyrophyllite as a diluent and small quantities of either Orvus or lignin pitch as a disperser. A mixture, ground by the manufacturers, of 20% crude 666 in gypsum was also tested.

Pure gamma 666 was distinctly more toxic than DDT. Crude 666 appeared somewhat less effective than would be expected from its gamma content, but this may possibly have resulted from the large amount of inert material used in processing it. The average efficiency of the different materials is given in Table 1.

Table 1. Relative Toxicity of 666 and DDT

Toxicant	Amt. per 100 gal.	Form	No. Tests	Average % Efficiency
DDT (99% pure)	0.25 lb.	DDT 10% Orvus 3% Pyrophyllite 87%	3	60.1
Gamma 666	0.25 lb.	Gamma 666 10% Orvus 3% Pyrophyllite 87%	3	73.6
DDT	0.50	DDT 10% Orvus 3% Pyrophyllite 87%	4	80.0
Gamma 666	0.50 lb.	Gamma 666 10% Orvus 3% Pyrophyllite 87%	3	93.3
Crude 666 (gamma equiv. 0.275 lb)	2.50 lb.	666 10% Lignin pitch 3% Pyrophyllite 87%	4	58.4
Crude 666 (gamma equiv. 0.550 lb)	5.00 lb.	666 20% Lignin pitch Pyrophyllite 77%	4	82.2
Crude 666 (gamma equiv. 0.550 lb)	5.00 lb.	666 20% Gypsum 80%	4	87.9

B. Comparison of DDT Formulations

Each individual test was run in duplicate, one series of unsprayed apples being used to test the toxicity of the fresh deposit while the duplicate was artificially "weathered" the day after spraying to determine the persistence of the residue. The third day after the fruit was sprayed, eggs were placed on both washed and unwashed fruits which were then incubated in the usual manner.

To "weather" the deposit, the racks of fruits were placed in a device which carried them at constant speed between the spray cones of two nozzles which were connected with the laboratory water supply through a pressure-regulating device. Each rack was passed three times through the spray of water, being allowed to dry after each treatment.

Because of day-to-day variations in the general level of establishment, only tests run on the same day, or same series of days, are comparable. Such comparable tests are grouped together and separated by lines in Table 2.

Micronized DDT, 50% pyrophyllite (no disperser added) supplied by Dr. C. H. Hadley of the U.S.B.E.P.Q. laboratory at Moorestown, N.J., was compared with the Geigy Company's proprietary Gesarol AK-40 (40% DDT) at 0.25 and 0.50 lb. per 100 gal. At the lower rate the micronized DDT was more effective in the fresh condition, but there was practically no difference in the residual toxicity of the two preparations after washing. At the 0.50 lb. rate, Gesarol AK-40 was essentially equal to the micronized DDT both as a fresh deposit and also after washing. In view of the difficulty in getting the micronized material to disperse in water, Gesarol AK-40 must be considered superior for practical use.

The addition of Orvus (30% sodium lauryl sulphate) at 0.2 lb. per 100 gal. to aid dispersion of micronized DDT had no obvious effect on the fresh deposit but greatly reduced its resistance to weathering. It is possible that a smaller amount of Orvus could be used for dispersion.

Because of an accident and scarcity of eggs it was not possible to run full series of tests in which either Orvus or blood albumin (Canada Packers' Soluble Blood Meal) at 0.2 lb. per 100 gal. were used with Gesarol AK-40. Averages therefore cannot be given but data from individual tests are given in Table 3. The effect of Orvus was not particularly evident but blood albumin greatly reduced toxicity, particularly of the washed deposit.

On another series, (Table 2) blood albumin even at the low rate of 0.07 lb. also greatly lowered the efficiency of the spray. In the same series calcium caseinate (25 parts casein, 75 parts hydrated lime) at 0.125 lb. per 100 gal. also reduced considerably the toxicity of Gesarol AK-40. This was essentially the same as the casein-lime adjuvent used with lead arsenate in British Columbia except that the lime content was somewhat less.

An 0.5% emulsion of summer oil (Imperial Markol HX, visc. 75-85 SSU, UR 96%) increased the initial toxicity of Gesarol AK-40, but had no effect in increasing persistence of the deposit. This was quite contrary to expectations.

The conclusion from all tests was that Gesarol AK-40 is a very efficient form of DDT with marked resistance to weathering. The addition of spreaders or other supplements had little effect or else reduced the persistence of the deposit.

C. Effect of DDT and Hexachlorocyclohexane on Adult Codling Moths

When codling moths were placed in battery jars, in an insectary, with twigs sprayed with Gesarol AK-40 2½ lb. (DDT 1 lb.) per 100 gal., females died within an average of 6.6 days as compared with 14.3 days in the checks, and were usually helpless for 1 to 3 days before death. An average of 6.5 eggs was laid per female in the treatments and 57.5 in the checks.

In another test where the twigs were sprayed with 50% DDT micronized in pyrophyllite, average longevity of females in treatments and checks was 5.5 and 12.5 days respectively, and average egg production 1.9 and 28.8 respectively. As the moths were from a different source, this experiment cannot be compared directly with the preceding one, but the micronized DDT in pyrophyllite appeared to be somewhat more rapid in its action than Gesarol AK-40.

When twigs with a dry deposit of Gesarol AK-40 were washed three times in an "artificial rain" machine, the effectiveness of the spray was considerably reduced, average female longevity being 7.0 days compared with 10.6 days for the unsprayed checks, while egg deposition was actually greater, 33.2 and 28.7 eggs per female respectively. When the twigs were not washed, they appeared to retain their full toxicity for at least three days after being sprayed.

666 (hexachlorocyclohexane) was used in the form of 20% of the refined material (about 30% gamma isomer) ground in pyrophyllite, sprayed at the rate of 1 lb. per 100 gal. Adult female codling moths placed in battery jars with twigs sprayed the same day (but dried before being used) died within an average of 3.5 days without producing any eggs; with twigs sprayed one day previously they lived 11.7 days and averaged 55.8 eggs. In the checks the females lived 14.3 days and averaged 57.5 eggs. Lack of codling moths prevented further tests with 666, but later work with oriental fruit moths had a direct bearing on the codling moth investigations and is given below.

Against oriental fruit moths a fresh (dry) deposit of 666 on twigs in battery jars gave complete mortality within one day; a day-old deposit was somewhat slower in action. Complete mortality within one day was also secured in a battery jar containing a freshly sprayed twig when the moths were confined within a screen cage, so that they could not come in contact with the spray deposit; and also when a strip of sprayed cloth enclosed in a screen cylinder was placed in a jar with moths and an unsprayed twig. A gauze-topped salve tin containing dry refined 666 placed in a jar reduced the average longevity of females to 4 days as compared with 8.8 days in the checks.

On the other hand, in wire screen cages 666 residues up to 5 days old on sprayed twigs did not significantly alter the longevity of oriental fruit moths. Females in the cages with fresher deposits actually laid considerably more eggs than in the corresponding checks, but as oviposition was generally erratic in the experiment this result may have been coincidental.

In conclusion, DDT residues on foliage are very toxic to adult codling moths, reducing both longevity and oviposition to a great extent. The efficiency of the residue against adults is rather easily reduced by rains, apparently more rapidly than the deposit on the fruit loses its effectiveness against the larvae.

Fresh residues of 666 give off vapours which are highly toxic in relatively confined spaces but would probably have little or no effect under orchard conditions

Table 2. Laboratory Tests of DDT against Newly Hatched Codling Moth Larvae

Materials per 100 gal.	No. of Replicates	% Efficiency Fresh	% Efficiency Washed
DDT 0.25 lb. (micronized)	4	82.4	48.4
Same plus Orvus 0.2 lb.	3	76.4	21.6
DDT 0.25 lb. (as Gesarol AK-40)	3	57.8	46.5
DDT 0.5 lb. (micronized)	4	89.7	64.3
Same plus Orvus 0.2 lb.	4	91.2	41.7
DDT 0.5 lb. (as Gesarol AK-40)	4	87.2	63.2
DDT 0.5 lb. (as Gesarol AK-40)	4	56.1	50.4
Same plus blood albumin 0.07 lb.	4	47.0	28.6
Same plus calcium caseinate 0.125 lb. (= casein 0.5 oz.)	4	50.0	34.6
DDT 1.0 lb. (as Gesarol AK-40)	4	84.4	76.7
Same plus Markol HX oil 0.5 gal. Calcium caseinate emulsifier 1 oz.	4	92.4	72.8

Table 3. Laboratory Tests of DDT against Newly Hatched Codling Moth Larvae

Materials per 100 gal.	Date Sprayed	% Efficiency Fresh	% Efficiency Washed
DDT 0.5 lb. (as Gesarol AK-40)	May 31	66.0	53.1
	May 31	55.7	50.8
	June 5	72.3	66.2
	June 5	-	-
	June 7	91.0	-
Same plus Orvus 0.2 lb.	May 31	59.2	43.2
	May 31	-	57.1
	June 5	65.6	61.8
	June 5	61.1	59.5
	June 7	87.4	75.7
Sa me plus blood albumin 0.2 lb.	May 31	-	11.3
	May 31	-	8.1
	June 5	50.5	35.6
	June 5	61.0	37.5
	June 7	54.2	15.5

AUSTRALIA

A. J. Nicholson, Division of Economic Entomology, Council for Scientific and Industrial Research, Canberra City, A. C. T.

CODLING MOTH (Cydia pomonella) CONTROL TESTS 1/

Seasons 1937-38, 1938-39, 1939-40.

Season 1937-38

Following on the tests carried out during the season 1936-37 on the orchard of Messrs. Oag Bros., Farm 520, Yanco, it was decided to continue this work, in part, during the 1937-38 season. These tests were carried out on the farm of Mr. E. Ison, Wamoon.

As mentioned in report for season 1936-37 the date of the last cover spray was 3/2/37 and the fruit was not picked until 7/4/37. During this period (3/2/37 to 7/4/37) moth activity, as indicated by lure traps and by number of late entries of grubs at time of harvesting, was fairly pronounced. It is my opinion that if another cover spray had been applied, say towards the end of February, better results would have been obtained. It was decided that during the 1937-38 season the application, or otherwise, of late cover sprays would depend upon moth activity, as indicated by lure traps in the field.

The following spray programmes were included in the tests;

(1) Lead arsenate 3 lb. to 100 gallons plus Calcium caseinate spreader 8 oz. to 75 gallons in the "calyx" and all "cover" sprays.

N.B. On 23/11/37, after the second cover spray had been applied, 10 lb. of Thiox were forwarded from Head Office with the request that it be tested out again this season. It was stated that the manufacturers had hopes that this batch of Thiox would prove to be more stable than the lot tested out in the 1936-37 season.

It was decided to use the Thiox (Thiodiphenylamine or Phenothiazine) at the rate of 3 lb. to 100 gallons in the remaining cover sprays, i.e. the 3rd, 4th, 5th and 6th. Needless to say, this was a somewhat unsatisfactory compromise but was due entirely to the firm handling this material not forwarding same earlier.

(2) The standard programme as recommended by the Department, namely: Lead arsenate 3 lb. to 100 gallons plus White Oil 1:100 in 2nd, 3rd and 4th cover sprays. Calcium caseinate spreader 8 oz. to 75 gallons in "calyx" and other "cover" sprays.

(3) Lead arsenate 3 lb. to 100 gallons plus Calcium caseinate 1/2 lb. to 75 gallons in calyx, 1st and 2nd cover sprays, followed by White Oil 1:100 plus Nicotine sulfate 1:600 in remaining cover sprays.

1/ Tests conducted in New South Wales.

(4) Lead arsenate 3 lb. to 100 gallons plus Calcium caseinate 1/2 lb. to 75 gallons in calyx, 1st and 2nd cover sprays followed by White Oil 1:100 in remaining cover sprays.

(5) Unsprayed check trees.

Berger's Lead Arsenate was used for these tests. According to the Victorian Department this brand has the following analysis:

Percent of declared active constituents.

Arsenic pentoxide AS_{205} calculated on dry basis.		Acidity - calculated as Nitric Dry basis.
Total.	Water Soluble	
31%	.50%	.2%

Neptune White Oil containing 85% White Mineral Oil, Neptune calcium caseinate and "Britnico" nicotine sulfate containing 40% nicotine were also used.

The thiox was supplied by Imperial Chemical Industries. This synthetic organic material is a stomach poison which is claimed to be more toxic than lead arsenate. It is a powder readily wetted by water and is used like lead arsenate. It is manufactured by heating diphenylamine with sulfur.

Spraying

The various sprays were applied with a power spray at a pressure varying from 250 to 300 pounds per square inch using long rods fitted with medium type of nozzles.

The trees - "Granny Smith" variety - 15 years old - being big trees required at least 6 gallons of spray fluid to ensure a thorough coverage.

Following are the dates the various sprays were applied:

Calyx Spray	4/10/37
First Cover Spray.....	21/10/37
Second Cover Spray	11/11/37
Third Cover Spray	3/12/37
Fourth Cover Spray	20/12/37
Fifth Cover Spray	17/ 1/38
Sixth Cover Spray	8/ 2/38

The applications of these sprays were timed according to moth activity as indicated by lure traps located in this block.

Orchard Sanitation:

1. All trees in this apple block were examined during September for overwintering larvae and at the same time all rough bark removed.

N.B. There proved to be a heavy population of overwintering grubs. Up to as many as 55 grubs were taken from the base of each tree 1" to 2" below ground level. More grubs were taken for 1" to 2" below ground level than on the whole of the above ground portions of the trees.

Many thousands of grubs were collected. It is of interest to record at this stage that the percentage of mothy fruit the previous season ranged between 40% and 50% according to the owner.

2. All the trees in the block, with the exception of the unsprayed check trees, were banded with chemically treated bands on 9/11/37. The check trees were banded with untreated corrugated cardboard bands and examined weekly from 9/11/37 on until end of season.

3. Fallen fruit picked up and examined weekly.

4. No "thinning" of crop carried out.

Lay-out of Experiment:

The five treatments were replicated five times using two tree plots in four instances and two single tree plots for the remainder on the randomized method of experimentation.

Climatic Conditions:

MONTH	SCREEN MEAN MAXIMUM	SCREEN MEAN MIN.	TERRESTRIAL MEAN	RAINFALL. No. of wet days	RAINFALL. Points
October	76.5°F.	53.1°F.	49.5°F.	7	171
November	83.8°F.	59.5°F.	54.1°F.	3	57
December	87°F.	62.3°F.	56.6°F.	5	115
January	88.4°F.	64.1°F.	55.1°F.	4	70
February	85°F.	61.5°F.	54.1°F.	4	55
March	86.3°F.	60.7°F.	53.9°F.	1	3

From the time of the calyx spray 4/10/37 up till time of harvesting 17/3/38 the amount of rain recorded was:

October ..... 168 points.
November ..... 57 points.
December ..... 115 points.
January ..... 70 points
February .... 55 points
March ..... 3 points

making a total of 468 points recorded on 23 days.

From 22/12/37 up to 14/1/38 very hot dry conditions prevailed throughout the Murrumbidgee Irrigation Area. The screen reading (maximum) were as follows:

22/12/37 - 96.5°F.
23/12/37 - 107°F.
24/12/37 - 103°F.
25/12/37 - 103°F.
26/12/37 - 93.5°F.
1/ 1/38 - 101°F.
2/1/38 - 94.5°F.
10/1/38 - 101°F.
11/1/38 - 104°F.
12/1/38 - 106.5°F.
13/1/38 - 95°F.
14/1/38 - 98.8°F.

RESULTS

Treatment Numbers		Sound Fruit	"Stings"	Infested	Grand Total	Ratio of Stings to Entrances
(1)	No.	8,979	1,334	574	10,887	2.3 : 1
	%	82.47%	12.26%	5.27%		
(2)	No.	6,416	910	255	7,581	3.6 : 1
	%	84.63%	12.01%	3.36%		
(3)	No.	7,561	999	247	8,807	4.04 : 1
	%	85.85%	11,35%	2.8%		
(4)	No.	9,906	1,244	376	11,526	3.3 : 1
	%	85.85%	10.98%	3.26%		
(5)	No.	576	195	8,691	9,462	0.022 : 1
	%	6.87%	1.28%	91,85%		

N.B. Above figures include "windfalls" and "harvested" fruit.

Observations:

(1) The high temperatures of the period 22/12/37 to 14/1/38 caused much sunscald of the fruit on the exposed western and northern aspects, especially on heavily laden trees where leaf growth was sparse and where limbs were bent over due to heavy crop. Even the fruit on the unsprayed check showed light scald.

Scalding of fruit sprayed with White Oil 1:100 in the 2nd, 3rd and 4th cover sprays together with lead arsenate was slightly more noticeable than on unsprayed trees.

Trees sprayed with Thiox showed the most sunscald.

N.B. Thiox was only used in two cover sprays, namely the third cover spray applied on 3/12/37 and the 4th cover spray applied 20/12/37 before heat wave. Furthermore, with Thiox, which turned black on the leaves and developing fruit several days after application, the sunscald area ultimately turned black increased in size, and in many instances cracked. Such fruit was unmarketable.

Russetting of the fruit occurred on all parts of the tree where Thiox was used as happened during the 1936-37 tests. (See Photos., December Agric. Gazette 1937).

(2) Where White Oil 1:100 plus Nicotine sulfate 1:600 was used in the 3rd, 4th, 5th and 6th cover sprays the harvested fruit was stained with dark patches which was in my opinion objectionable.

Fruit from trees which received White Oil 1:100 alone in the 3rd, 4th, 5th and 6th cover sprays was not stained. It would appear therefore that this staining was due to the nicotine sulfate.

(3) Fruit from trees sprayed with (a) White Oil 1:100 plus Nicotine sulfate 1:600, and (b) White Oil 1:100 were very oily to handle and dull in appearance (besides being stained in case of (a)) when compared with fruit which received the "standard" programme. This dull oil film was very hard to remove. Brushes on grading plants removed very little of this oil film or the "stain."

Discussion:

(1) Considering the heavy infestation of the previous season (1936-37), and the percentage of mothy fruit - 91.85% - on the unsprayed trees, most satisfactory results were obtained, especially with spray programmes Nos. 3-4-2, and 1, although the percentage of "stings" was relatively high in all instances.

The percentage of sound fruit in each instance closely approximated one another - 82.47% for the lowest and 85.85% for the highest; however, after considering: (a) effect of spray on fruit in case of (1) Thiox (2) White Oil plus Nicotine sulfate and (3) White Oil as mentioned under observations, and (b) costs in case of White Oil and Nicotine sulfate, it is my opinion that the "standard" programme is still the best and safest for control of Codling Moth.

(2) Until Thiox is stabilized and so oxidation is prevented under atmospheric conditions, sunscalding, cracking and russetting of fruit will result. At present it cannot be classed as a "safe" spray.

(3) There is very little appreciable difference between the results obtained from the programmes where (a) White Oil 1:100 plus Nicotine sulfate 1:600 and (b) White Oil 1:100 were used in the 3rd, 4th, 5th and 6th cover sprays. On these results the addition of Nicotine sulfate to White Oil does not appear necessary.

(4) The question of "stings" is a complex one. In report for 1936-37 season it was mentioned that the blotched effect, i.e. uneven coverage obtained when lead arsenate and white oil are mixed, could possibly be correlated with the relatively high percentage of "stings" and that this blotched effect may be overcome by the addition of small quantities of a

spreader such as Calcium caseinate. In these tests (1937-38) Calcium caseinate at the rate of 8 ounces to every 75 gallons of Lead arsenate-White Oil spray was added. The blotched effect was still noticeable and the percent of "stings" not reduced. Possibly the percentage of "stings" may be bound up with the severity or otherwise of the "over-wintering" population.

SEASONS 1938-39 and 1939-40.

During the two seasons referred to above control tests were carried out using miscible white oil at the rate of 1:200 in the second, third and fourth cover sprays in combination with the lead arsenate used at the rate of 3 pounds to every 100 gallons.

In the 1938-39 tests the above spray programme was included, along with other combinations, in the detailed control tests using two tree plots replicated four times on the orchard of Mr. E. Ison, Wamoon, Leeton.

In the 1939-40 season a comparative control test, using a miscible white oil at the rate of (A) 1:100 and (B) 1:200 in the second, third and fourth cover sprays, was carried out on the block of Mr. D. Letheven, Fivebough, Leeton.

Season 1938-39.

The following spray programmes were included:

(A) Lead arsenate 3 lb. to 100 gal. plus White Oil 1:100 in the 2nd, 3rd, and 4th cover sprays.

(B) Lead arsenate 3 lb. to 100 gal. plus White Oil 1:200 in the 2nd, 3rd and 4th cover sprays.

(C) Lead arsenate 3 lb. to 100 gal. plus White Oil 1:200 in 1st, 2nd and 3rd cover sprays.

(D) Lead arsenate 3 lb. to 100 gal. plus Fish Oil (De Meric's) 1 pint to 75 gal. in 1st, 2nd and 3rd cover sprays.

(E) Unsprayed check trees.

N.B. In the "calyx" spray and "cover" sprays, other than mentioned above, Calcium caseinate, as spreader, was used at the rate of 10 ounces to every 100 gallons of Lead arsenate spray.

The sprays were applied on the following dates:

Calyx spray	14/10/38
First cover spray	28/10/38
Second cover spray	15/11/38
Third cover spray	8/12/38
Fourth cover spray	5/ 1/39
Fifth cover spray	4/ 2/39
Sixth cover spray	28/ 2/39

Application of the various sprays timed according to "catches" of moths in lure traps located on this block.

Sprays were applied with a power spray developing a pressure of 250-300 pounds per square inch using long rods fitted with medium type nozzles. Channel water was used as a diluent.

These trees - "Granny Smith" variety - being big trees, required between 5 and 6 gallons per tree in order to thoroughly cover all parts.

Berger's Lead Arsenate was used, which is said - according to Victorian Department of Agriculture - to have the following composition:

Arsenic pentoxide (AS_2O_5) calculated on a dry basis.		Acidity - Calculated as Nitric Dry Basis.
Total	Water Soluble	
31%	0.50%	0.2%

Neptune White Oil - 85% White Mineral Oil and Neptune Calcium caseinate used.

Orchard Sanitation:

1. Trees were banded with chemically treated bands on 14/11/38. These trees were banded the previous season with similar type of bands which caught on an average slightly over 30 grubs per band.

2. Fallen fruit was picked up at weekly intervals.

3. Owing to relative light crop no "thinning" was carried out.

N.B. What with the light crop a very dense and profuse leaf growth resulted which made thorough spraying somewhat difficult.

Climatic Conditions:

MONTH	SCREEN MEAN MAX. TEMP.	SCREEN MEAN MINIMUM	TERRESTRIAL MEAN	RAIN No. of Wet Days	RAIN Points
October	78°F.	53.5°F.	48.1°F.	8	168
November	87°	59.9°	54°	1	5
December	89.8°	61.5°	52.2°	-	-
January	107.4°	72.3°	68.3°	-	-
February	94.7°	67.6°	61.7°	5	180
March	77.7°	60.7°	57.7°	11	619

Rainfall recorded from time of calyx spray (14/10/38) to time of picking (31/3/38):

October ..... 145 points - on 6 days
November ..... 5 points - on 1 day
December ..... - points
January ..... -
February ..... 180 points - on 5 days
March ..... 619 points - on 11 days.

The normal spring winds of October and November were fairly persistent.

The average (screen mean maximum) temperatures for October, November and December were the highest on record since 1914, while the temperatures for January and February of 1939 broke all records. From 2/1/39 to 14/1/39 inclusive extreme heat wave conditions prevailed, as indicated by the following screen readings:

Date	Maximum Screen Temperature	Relative Humidity
2/ 1/39	104.1°F.	15%
3/ 1/39	102°	15%
4/ 1/39	99.9°	22%
5/ 1/39	102°	21%
6/ 1/39	105.8°	22%
7/ 1/39	108°	23%
8/ 1/39	110.9°	19%
9/ 1/39	108°	17%
10/ 1/39	115°	16%
11/ 1/39	117°	15%
12/ 1/39	113.1°	19%
13/ 1/39	115.2°	17%
14/ 1/39	112.6°	14%

RESULTS:

Major portion of crop was harvested during first week of April.

Treatment		Sound	Stings	Infested	Grand Total	Ratio of Stings to Entrances
(A) White Oil 1:100 in 2nd, 3rd, & 4th cover sprays.	No.	1,632	207	62	1,901	3.34 to 1
	%	85.84%	10.9%	3.26%		
(B) White Oil 1:200 in 2nd, 3rd & 4th cover sprays.	No.	2,637	273	69	2,979	3.95 to 1
	%	87.79%	9.9%	2.31%		
(C) White Oil 1:200 in 1st, 2nd & 3rd cover sprays.	No.	1,969	226	67	2,262	3.37 to 1
	%	87.05%	9.99%	2.96%		
(D) Fish Oil 1 pint to 75 gallons.	No.	1,682	289	102	2,073	2.83 to 1
	%	82.33%	13.9%	4.77%		
(E) Unsprayed check trees.	No.	240	11	798	1,049	0.013 to 1
	%	22.87%	1.06%	76.07%		

N.B. Above figures include "windfalls" and "picked" fruit.

Observations:

(1) It can be seen from the above figures that the crop was not only light but varied markedly from tree to tree.

(2) Taking into consideration the extreme heat during the season it was to be expected that much sunscald would develop; however, such was not the case. As mentioned above a dense mass of foliage protected majority of fruits. Where fruits were exposed sunscald was noticeable but not to the same extent as in previous season.

None of the above-mentioned spray programmes accentuated sunscald.

Discussion:

The objective in using the miscible white oil 1:200 and fish oil - 1 pint to 75 gallons - in the first, second and third cover sprays was to ascertain if it was possible to reduce the percentage of "stings." The percentage of "stings" had always been relatively high in tests carried out in previous seasons.

The above results do not indicate any improvements in the reduction of "stings" by the two mentioned modifications of the "standard" programmes.

Most satisfactory results were obtained with the three combinations of lead arsenate and white oil at 1:100 and 1:200. The results with lead arsenate plus fish oil were not, comparatively speaking, so satisfactory.

Season 1939-40

Owing to the variability of the crop from tree to tree in the tests carried out the previous season (1938-39), it was decided to carry out a comparative test this season with the following programmes:

(A) Lead arsenate 3 pounds to 100 gallons plus White Oil 1:100 in the 2nd, 3rd and 4th cover sprays.

(B) Lead arsenate 3 pounds to 100 gallons plus White Oil 1:200 in the 2nd, 3rd and 4th cover sprays.

The promising results obtained with programme (B) during the previous season warranted this comparative test.

This test was carried out on the orchard of Mr. D. Lethevens, using "Granny Smith" and "Delicious" apple trees. Nineteen trees were sprayed with each spray programme.

Berger's Lead Arsenate, Neptune White Oil and Neptune Calcium Caseinate were used.

N.B. "Fluxit" spreader at the rate of one-third of a pound for 100 gallons was used in the "calyx" spray.

Calcium caseinate was used at the rate of 6 ounces to every 100 gallons of lead arsenate spray in the first and fifth "cover"sprays.

A most efficient power spray, developing 300-350 pounds per square inch and fitted with medium type nozzles on short rods, was used to apply the sprays.

Channel water was used as a diluent.

The trees were not big trees and required approximately 2 1/2 gallons of spray for thorough coverage.

The various sprays were applied on the following dates:

Calyx spray	16/10/39
First Cover spray	30/10/39
Second Cover spray	13/11/39
Third Cover spray	7/12/39
Fourth Cover spray	29/12/39
Fifth Cover spray	22/ 1/40

Applications timed according to moth activity as indicated by lure traps.

N.B. As fruit was very free from moth and because it was harvested towards end of February the application of a further cover spray was not warranted.

Weather Conditions:

MONTH	SCREEN MEAN MAXIMUM	SCREEN MEAN MINIMUM	TERRESTRIAL MEAN	RAIN	
				No. of Wet Days	Points
October	70.6°F.	47.8°F.	40.6°F.	9	336
November	76.7°F.	54.1°F.	47°F.	10	252
December	85.4°F.	56.6°F.	43.7°F.	2	14
January	91.6°F.	63.2°F.	53.7°F.	1	21
February	88.2°F.	57.3°F.	45.8°F.	1	10

From 16/10/39 up to end of February 1940, 404 points of rain were recorded on seventeen days.

Compared with previous season mild wet conditions prevailed up to 21/11/39 and from then on until harvesting warm and dry atmospheric conditions resulted.

Orchard Sanitation:

1. Chemically treated bands were not used nor had they been used in previous seasons.

2. Fallen fruit was picked up at weekly intervals.

3. Owing to relative light crop no "thinning" operations were carried out.

A marked drop of fruit early in December resulted. This fruit was seedless, such being caused by Thrips.

RESULTS:

Fruit was harvested during last days of February.

Programme		Sound	Stings	Infested	Grand Total	Ratio of Stings to Entrances
(A) White Oil 1:100	No.	5,269	224	61	5,554	3.67 to 1
	%	94.8%	4.05%	1.15%		
(B) White Oil 1:200	No.	6,361	335	74	6,770	4.52 to 1
	%	93.95%	4.94%	1.11%		

N.B. Above figures include "windfalls" as well as "picked" fruit.

Observations

(1) No sunscald of fruit, even on those exposed, was observed with either of the above spray programmes.

(2) Variability of the crop from tree to tree can be observed when above results are studied.

Discussion

The results obtained with both spray programmes were most satisfactory and are comparable.

For the past two seasons 1938-39 and 1939-40 a miscible white oil at the rate of 1:200 added to the 2nd, 3rd and 4th cover sprays has given most satisfactory results when compared with standard programme, i.e. White Oil 1:100 in 2nd, 3rd and 4th cover sprays.

There is little need to say that the apple industry is in the midst of a crisis and any means by which costs of production can be reduced should be thoroughly explored.

Here in the Murrembidgee Irrigation Area spray costs are high. The addition of a miscible white oil at the rate of 1:100 to the 2nd, 3rd and 4th cover sprays, costs on an average 8.9d. per tree. By using White Oil at half this strength, i.e. 1:200, a saving of 33/4 per acre (90 trees per acre) will result. This is based on oil at 4/11 a gallon. As it is reasonable to expect an increase in price for spraying oil now, the spray costs per tree or per acre will increase correspondingly.

Note: Mr. Nicholson has advised that no codling moth work was carried on in Australia during the war but that it is now being resumed. The foregoing report of work on the codling moth at Leeton by the New South Wales Department of Agriculture during the seasons 1937-40 covers some of the last work done before the war and is included as of general interest.

Further information on the codling moth in Australia can be found in Department of Agriculture, Victoria Technical Bulletin No. 1, March 1943 by L. W. Miller entitled "Codling Moth in Williams' Pears, Investigations in the Goulburn Valley, Victoria, 1936-1941."

Dow Chemical Company

O. H. Hammer, Midland, Michigan

Extremely early spring growth followed, during and soon after bloom, by several periods of freezing temperatures, frequent rains, and almost continuous strong winds resulted in severe crop reductions in all Southwestern Michigan apple orchards. Many plantings set no apples at all or so few that no effort was made to control codling moth. Some growers attempted to remove what apples did set thereby obviating the need for worm control. Where an attempt was made to control codling moth on light crops with lead arsenate and/or other insecticides the results generally were very poor.

An extensive examination of orchards in Allegan, Van Buren and Berrien Counties was necessary to locate a satisfactory site for 1945 codling moth control studies. The planting selected for this work consisted of a block of 25 year old Jonathan trees situated at a high elevation near the town of Coloma, Michigan. Even in this orchard the total crop was only about 15 to 20 percent normal with extreme tree to tree variations in production. Only those trees which bore 4 or more bushels were used for record purposes. Five such record trees were available in each plot.

The 1945 studies were concerned with (1) Control of codling moth, red mite and other insects which might be encountered; (2) Observations on compatibility of spray mixtures with reference to insect control and phytotoxicity; and (3) Observation on quality and appearance of fruit at harvest.

Results. Two series of comparisons are discussed here. The first is concerned with the use of lead arsenate in all covers, either alone or with certain other insecticides. A summary of these comparisons is presented in table 1.

It is obvious that under the conditions of a small crop and heavy worm attack lead arsenate alone was entirely inadequate. The use, with lead arsenate, of one or more of the following materials; Triton B-1956, DN-111, DN Dry Mix No. 1, micronized phenothiazine and DDT resulted in codling moth control of various degrees of improvement over lead arsenate alone. Control of the European red mite was satisfactory only where the dinitro materials were used. No injury to fruit or foliage resulted from the use of DN-111. Slight scorching of margins and tips of young succulent leaves followed the use of DN Dry Mix in the third cover. Similar injury did not occur when this material was used in the 4th and 8th covers. What injury did occur from the 3rd cover was quickly masked by further growth, and was certainly less important than the mite damage on plots not so sprayed. The dinitro compounds added little or nothing to aphis control. In this discussion reference is to the green aphis which was of general distribution and unusually severe in 1945. Control of this pest is expressed in

the tables in 2 ways, (1) as per cent of terminals infested, and (2) by size of apples harvested. Observations during the season showed that fruit size was closely correlated with intensity of aphis infestation. Phenothiazine with lead arsenate in 4 of 9 covers resulted in greatly improved codling moth control, (Compare item 1 with 5 and 3 with 6). This material apparently had little or no effect on aphis. The use of phenothiazine resulted in dark purplish-green foliage which in itself was probably not harmful, although apples from these trees were more highly colored and slightly more mature at harvest than fruits from straight lead sprayed plots. No spray injury resulted from the use of DN-111 with phenothiazine, and there was a substantial reduction in the red mite population and injury caused by this pest. The use of Triton B-1956 (Rohm and Haas) again appeared to increase the effectiveness of lead arsenate, but this increase was not as great as was the case in 1943 or 1944. DDT used at ½ pound in 100 gallons with lead arsenate resulted in excellent control of both codling more and aphis, (Compare items 1 and 7 of table 1). By late August the foliage in the DDT sprayed plot showed extensive bronzing due to a heavy red mite population.

The second series of tests is concerned with comparisons of the performance of various DDT schedules. Limitations in suitable experimental trees prevented more varied and extensive tests. Table 2 contains a summary of the results obtained with this material.

DDT used at ½ and 1 pound in 100 gallons in 8 covers gave excellent codling moth and green aphis control. There is a slight indication that better control resulted with the 1 pound than with ½ pound, and it is probable that this difference would be greater with fewer applications. The use of DN-111 and DN Dry Mix with DDT caused no injury to fruit and foliage, nor did it reduce codling moth and green aphis control. Plots which received DDT and no material for mite control showed extensive bronzing of the foliage. A large increase in red mite populations in plots sprayed with DDT alone was general with the exception of the one which received 1 pound in 100 gallons. (Item 2, table 2). Even here the population on the final count date was large. The relatively slow build up might possibly have been due to the location of this plot which consisted almost entirely of trees on an outer edge of the orchard. Plots which received DN-111 and DN Dry Mix had very light mite populations until early in September when the protection of these materials apparently ran out. Since at this time the foliage was in excellent condition thus affording ample food, the rate of mite increase was greater than on plots which had long supported heavy mite populations. However, no bronzing of the foliage occured in the dinitro treated areas since cool weather after September 10 resulted in a cessation of mite feeding.

Size, quality and finish of fruits from all DDT Sprayed plots was good.

Table 1.

Items	Materials and Amts./100 gal.	Covers [1]	Codling Moth Clean Apples (%)	Codling Moth Worms per 100 Fruits	Red Mites per leaf on July 31	Red Mites per leaf on Aug. 20	Red Mites per leaf on Aug. 30	Red Mites per leaf on Sept. 7	Gr. Aphis Terminals Infested (Percent)	No. Apples Per Crate
1	Lead Ars. (3) Zinc-Lime (1-3)	2nd to 9th	38.2	15.6	.46	2.46	6.06	9.13	69.4	309
2	Lead Ars. (3) Zinc-Lime (1-3) Triton B-1956 [2] (4 oz)	2nd to 9th	48.8	10.3					62.0	262
3	Lead Ars. (3) Zinc-lime (1-3) DN-111 [3] (20 oz)	2nd to 9th in 2,5,6,7,9 in 3,4,8	43.4	18.2	.02	.56	1.62	2.78	47.4	217
4	Lead Ars. (3) Zinc-lime (1-3) DN Dry Mix No. 1 [4] (8 oz)	2nd to 9th in 2,5,6,7,9 in 3,4,8	53.6	8.1	0.0	0.22	0.6	2.94	56.4	232
5	Lead Ars. (3) Phenothiazine (2) Zinc-lime (1-3)	2nd to 9th in 2,3,4,8 in 5,6,7,9	67.0	6.0	0.62	6.52	11.0	28.7	38.0	202
6	Lead Ars. (3) Phenothiazine (2) DN-111 (20 oz) Zinc-lime (1-3)	2nd to 9th in 2,3,4,8 in 3,4,8 in 5,6,7,9	69.6	4.1	0.30	1.52	3.18	7.98	42.0	209
7	Lead Ars. (3) Zinc-lime (1-3) DDT [5] (8 oz)	2nd to 9th	98.0	0.75	4.56	43.2	30.8	47.6	7.6	151

1/ Lead Arsenate 4 lbs/100 gallons on all plots in 1st cover, May 28. Wettable sulfur used in 1st and 2nd covers on all plots. Covers 2 to 9 inclusive were applied June 11, June 21, July 2, July 11, July 20, July 30, Aug. 8 and Aug. 20.

2/ Triton B-1956 a product of Rohm and Haas Company.

3/ DN-111 contains 20% of the dicyclo hexyl amine salt of dinitro ortho cyclo hexyl phenol.

4/ DN Dry Mix No. 1 contains 40% of dinitro ortho cyclo hexyl phenol.

5/ DDT dozages are expressed as actual toxicant. The product used was a Dow formulation containing 40% DDT.

Table 2.

Items	Materials and Amts./100 gal.	Covers 1/	Codling Moth: Clean Apples (%)	Codling Moth: Worms per 100 Fruits	Red Mites per leaf on: July 31	Aug. 20	Aug. 30	Sept. 7	Gr. Aphi: Terminals Infested (Percent)	No. Apples per Crate
1	Lead Ars. (3 lb) Zinc-Lime (1-3))	2nd to 9th	38.2	15.6	.46	2.46	6.06	9.13	69.4	309
2	DDT 2/ (1 lb)	2nd to 9th	97.3	0.55	1.2	11.1	9.7	37.4	0.6	172
3	DDT (1 lb) DN-111 3/ (20 oz)	2nd to 9th in 3,4,8	99.0	0.26	0.08	0.4	0.66	7.98	6.2	150
4	DDT (1 lb) DN-Dry Mix No.1 4/ 8 oz)	2nd to 9th in 3,4,8	99.5	0.1	0.12	0.68	1.08	21.5	6.8	154
5	DDT (8 oz)	2nd to 9th	96.4	0.72	4.56	43.2	30.8	47.6	13.8	167
6	Lead Ars. (3 lb)) Zinc-lime (1-3)) DDT (8 oz))	2nd to 9th	98.0	0.75	1.3	11.4	24.3	42.8	7.6	151

1/ Lead Arsenate 4 pounds and wettable sulfur 5 lbs/100 gallons used on all plots in the 1st cover spray applied May 28. In addition to the materials listed above wettable sulfur 4 pounds/100 gallons was used in the 2nd cover. Application dates for the 2nd to 9th covers respectively were June 11, June 21, July 2, July 11, July 20, July 30, Aug. 8 and Aug. 20.

2/ DDT dosages are expressed as actual toxicant. The product used was a Dow formulation containing 40% DDT.

3/ DN-111 contains 20% of the dicyclo hexyl amine salt of dinitro ortho cyclo hexyl phenol.

4/ DN Dry Mix No. 1 contains 40% of dinitro ortho cyclo hexyl phenol.

E. I. du Pont de Nemours & Co., Inc.

H. F. Dietz, R. Sutton and M. C. Swingle, Grasselli Pest Control Research Section, Wilmington, Delaware.

CODLING MOTH FIELD CONTROL EXPERIMENTS - 1945, GLASSBORO, NEW JERSEY

Experiments on codling moth control were conducted in an orchard of Starking apples near Glassboro, New Jersey. The single tree randomized block system with six replications was used. Approximately one-third of a normal crop was harvested because of spring freezes.

Du Pont technical grade DDT, formulated as dispersible powders containing 25 percent and 50 percent DDT, and technical grade 2,2-di(p-methoxyphenyl)-1,1,1-trichloroethane as a 25 percent dispersible powder were used. All compositions had a particle size of 5 microns or less. Differentiation of treatments was started with the second cover spray.

FERMATE fungicide, 1 pound, was used in the 1st, 3rd and 4th cover sprays in all treatments, followed by 1/2-3-100 Bordeaux in part of the treatments and FERMATE fungicide 3/4 pound, in the remaining ones as indicated in Table I. No fungicide was used in the 2nd cover spray. Three quarts of summer oil emulsion (83 percent oil) was added to the lead arsenate treatment No. 7 and DDT treatment No. 4 in the 4th, 5th and 6th cover sprays.

The spray dates for codling moth control were as follows: calyx (lead arsenate all blocks) April 16; 1st cover spray (lead arsenate all blocks) April 26; subsequent differentiated cover sprays, May 5, 12, 22, 31; June 11, 21; July 2, 12, 23; and August 3 (last spray). Harvest was September 5. European red mite sprays were applied in Experiment 1, on July 24, and counts made July 31. In Experiment 2, the sprays were applied August 14 and 20, and the counts made August 20 and 28.

No direct foliage injury was observed from any treatment. At Harvest, the appearance of the foliage on the trees sprayed with 2,2-di (p-methoxyphenyl)-1,1,1-trichloroethane was darker green in color and more vigorous than that of any other treatment. Wherever oil was used in combination with DDT, the foliage was brittle and very poor in color and vigor. The fruit from each treatment was of equal quality.

A rapidly increasing mite population was observed July 2 ~~and~~ on trees sprayed with DDT without oil. The mites persisted until the end of the season. During the entire month of July, a heavy infestation of green apple aphids on sucker growth occurred on all trees, irrespective of treatment. The DDT sprays had no noticeable effect on the aphids. No observations were made on beneficial insects.

With the exception of one sample (taken from trees receiving Treatment No. 1 - Table I), the DDT residue on the harvested fruit was well under the tentative tolerance of 7 ppm. All fruit was brushed before packing, but no analyses of the residues remaining on brushed fruit were made.

European red mite occurred on all trees, irrespective of treatment, but population build-up was greater on DDT sprayed trees than on those sprayed with 2,2-di(p-methoxyphenyl)-1,1,1-trichloroethane, or those where summer oil was used.

In the mite control experiments, 2'-hydroxy-2,4,4,4 ,7-pentamethylflavan, prepared as a 25 per cent dispersible powder and used at 4 pounds per 100 gallons, was compared with a 1 per cent oil emulsion (Table 2). In a separate test, a 1-1/2 per cent oil emulsion, applied to trees with a very heavy mite population, caused serious defoliation.

CODLING MOTH CONTROL - GLASSBORO, N.J. - 1945

TABLE I

Insecticide (per 100 gals.)	Percentage fruits Clean	Wormy	Stung	Worms per 100 fruits	Stings per 100 fruits	Total DDT at Harvest Colormetric Method	Total Cl Method
1. DEENATE 25-W (25% DDT) 1 lb. DDT + Bordo	98.0	0.2	1.8	0.2	2.0	9.3 ppm	5.7 ppm
2. DEENATE 25-W (25% DDT) 1/2 lb. DDT + Bordo	97.7	0.1	2.2	0.1	2.2	5.0	3.1
3. DEENATE 25-W (25% DDT) 1/2 lb. DDT + FERMATE	96.9	1.1	2.0	1.2	2.6		
4. DEENATE 25-W (25% DDT) 1 lb. DDT + Oil + Bordo	98.7	0	1.3	0	1.3		
5. DEENATE 50-W (50% DDT) 1/2 lb. DDT + Bordo	97.4	0.5	2.1	0.6	2.4	5.2	3.5
6. 2,2-Di(p-methoxyphenyl)-1,1,1-trichloroethane, 1 lb. + FERMATE	98.4	0.5	1.1	0.5	1.1		
7. Lead Arsenate, 3 lbs. + oil + Bordo	82.7	5.4	11.9	9.1	33.0		
8. Grower's Treatment, Black Leaf 155 + Oil	90.6	3.1	6.3	3.1	7.5		

CONTROL OF EUROPEAN RED MITE ON DDT SPRAYED APPLE TREES, GLASSBORO, N.J. - 1945

Variety: Starking

TABLE 2

Treatment		Average Mites Per Leaf Before Spraying	% Control One Spray	% Control 2 Sprays
Experiment 1.				
Hydroxypentamethylflavan	0.125% flavan	116	91	
Oil emulsion (83% oil)	1.0% oil	77	95	
Untreated		41	+20	
Experiment 2.				
Hydroxypentamethylflavan	0.125% flavan	127	68	88
Oil emulsion (83% oil)	1.0% oil	110	76	93
Untreated		90	+39	+38

April 22, 1946

UNITED STATES DEPARTMENT OF AGRICULTURE

Agricultural Research Administration

Bureau of Entomology and Plant Quarantine

RESULTS OF CODLING MOTH INVESTIGATIONS, 1945

Part II

Work Conducted by the Bureau of Entomology
and Plant Quarantine, Agricultural Research
Administration, U. S. Department of
Agriculture

Not for Publication

(Not for Publication)

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U. S. Department of Agriculture

This summary represents the contribution of the Division of Fruit Insect Investigations of the Bureau of Entomology and Plant Quarantine to the pool of information on the results of codling moth investigations carried on during 1945 which has been prepared in accordance with a request made by the Committee on the Codling Moth of the American Association of Economic Entomologists. As in previous years, this is a preliminary report, circulated for the information of those interested. It is subject to revision as further review of the data may indicate, and has the status of unpublished data, not subject to quotation without permission.

The work of the Division of Fruit Insect Investigations is carried on cooperatively with several Bureau and Department units, as well as with a number of State agencies. The Division of Insecticide Investigations has continued to contribute to the work reported herein, and joint field laboratories are maintained at Yakima, Washington, and at Vincennes, Indiana. The work in West Virginia is carried on jointly by the West Virginia Agricultural Experiment Station and the Bureau; the work in New York is carried on similarly with the New York Agricultural Experiment Stations.

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POUGHKEEPSIE, NEW YORK

D. W. Hamilton, Bureau of Entomology and Plant Quarantine, Agricultural Research Administration, U. S. Department of Agriculture, and J. L. Brann, Jr., New York Agricultural Experiment Station.

These investigations were carried on jointly by the Bureau of Entomology and Plant Quarantine and the New York Agricultural Experiment Station at the Hudson Valley Fruit Investigations Laboratory, Poughkeepsie, N. Y.

The number of living codling moth larvae at the beginning of the 1945 season in the Hudson River Valley was greater than average since the number that entered hibernation in the fall of 1944 was extremely high and mortality during the 1944-45 winter season was moderate.

Due to the unseasonably high temperatures that occurred in March, the first pupae were found near Poughkeepsie March 29, over three weeks earlier than in any previous year. Previously, pupae had not been found prior to April 21 (1942 record) and in 1944 the first ones were not found until May 1.

Spring-brood moths were first captured in bait traps May 12; they were taken in largest numbers May 25 and 26 and in small numbers from May 27 to June 13, a period during which temperatures were comparatively low and rainfall heavy. Spring-brood moths continued to be present well into July.

The first larval entries in fruit were found May 29 but, because of unfavorable weather conditions, few were found prior to June 8. Injury by first-brood worms began to appear at an alarming rate June 18, appeared at a high rate from then to about July 10, and at a moderate rate through July 20. An unusually high percentage of the injury caused by the first brood occurred during the latter part of its period of activity, late in June and early in July.

In the insectary, first-brood adults began emerging July 17 whereas they have appeared as early as July 4 in other seasons. In orchards, increased captures of moths in bait traps July 26 indicated the presence of first-brood adults. Peak numbers of first-brood moths were taken in bait traps from August 1 to 5, August 11 to 17, and August 27 and 28. Second-brood injuries were evident in most orchards by August 6, occurred in greatest numbers from August 10 to 20, and continued to occur to some extent throughout September in orchards containing unharvested fruit.

Although weather conditions in 1945 were not so favorable as those in 1944 for codling moth development, infestations continued to be severe. This was partly due to the heavy carry-over of larvae from the previous season, combined with a light crop and rapid growth of the fruit, which made it more difficult to maintain adequate spray protection. Codling moth injury in 1944 was at an all time high for this area. Evaluation of experimental data indicates that each season it becomes increasingly difficult to maintain the same level of control when lead arsenate is used in a similar spray schedule. In 1940 and 1941 clean fruit in trees receiving 6 lead arsenate cover sprays averaged better than 90 percent; in 1942 and 1943 it averaged 89 and 73 percent, and in 1944 and 1945 it averaged 65 and 35 percent.

Field Tests of Insecticides

Spray Experiments - Woolsey Orchard, Milton, N. Y.

In this orchard solid rows of McIntosh trees were alternated with rows of Cortland and Red Bird trees. Loss of the crop during the freeze after trees were in bloom made it necessary to run the experimental tests on 3 single-tree replicates of McIntosh and 2 single-tree replicates of Cortland trees, rather than on 5 replicates of McIntosh as originally planned. All trees were slightly above average in size; while the final set of fruit was below that normally picked on such trees, it was well distributed. Plots 16 to 18 were of McIntosh only.

All plots except number 16 received early-season sprays consisting of a calyx, 1st curculio and scab, and 4th curculio and scab applications of lead arsenate 3 pounds, lime 3 pounds, and micronized wettable sulfur 6 pounds to 100 gallons. The 2nd and 3rd curculio and scab applications were 20-80 lead arsenate-sulfur dusts. Extra scab applications were needed in 1945 because of the long period and excessive rainfall between calyx and 1st cover applications. Plot 16 was sprayed with micronized wettable sulfur at the time of the calyx, 1st curculio and scab, and 4th curculio and scab applications, but was not dusted at the time of the 2nd and 3rd scab applications. Six pounds micronized wettable sulfur was included in all 1st cover sprays and on Plot 16.

Generally 6 cover applications were applied, 4 against first-brood worms and 2 against the second-brood. McIntosh were picked September 3 to 6; the Cortlands remained on the trees until late that month and suffered a much more severe worm attack. Apparently protection was poor late in the season. The dates on which applications were made and of harvest, and the amount of rainfall occurring between dates follow.

Date		Rainfall Since Preceding Date (Inches)
Calyx	April 21	
1st curculio and scab	May 3	2.90
2nd curculio and scab (dust) ...	May 14	3.49
3rd curculio and scab (dust) ...	May 18	1.31
4th curculio and scab	May 21	1.53
1st cover	June 1-6	1.67
2nd cover	June 14	0.01
3rd cover	June 25	3.59
4th cover	July 6-7	1.58
5th cover	August 8-9	13.75
6th cover	August 16-17	0.00
Fruit harvested McIntosh	September 3-6	4.70
Cortland	September 26-27	3.03
	Total	37.56

Treatments tested and results obtained are shown in Table 1. Schedules have been grouped so that similar materials may be readily compared.

Table 1. Codling Moth Spray Experiments - Woolsey Orchard, N. Y. - 1945
Varieties - McIntosh (Mc) and Cortland (Ct)

Plot	Covers	Materials 1/ (Amounts per 100 gallons)	Apples per Tree	Apples Clean Percent	Number per 100 Apples Worms	Number per 100 Apples Stings	Harvest Residues 2/ Gr. per lb. As_2O_3	Harvest Residues 2/ Gr. per lb. Pb	Harvest Residues 2/ Gr. per lb. DDT
									Average
16	0	No Insecticides	Mc-1386	33.5	96.0	23.3	.001	.002	
		Lead Arsenate							
1	1-6	LA 3 lb., L 3 lb.	Mc- 902	50.2	24.6	83.5	.082	.203	
			Ct- 769	45.2	48.9	83.5			
17	1-2	LA 3 lb., L 3 lb.	Mc-1192	49.2	60.2	43.8	.007	.020	
		DDT							
7	1-6	25% DDT - 1 lb.	Mc-1505	97.3	0.3	2.8			
			Ct- 914	90.0	4.4	8.4			
2	1-6	50% DDT - 1 lb.	Mc-1846	95.0	1.2	4.3			
			Ct-1392	88.1	2.4	12.3			
4	1-6	50% DDT - 1 lb. B.A. 8oz.	Mc-2701	96.4	1.2	3.1			
			Ct-1055	87.7	3.1	11.8			
3	1-2	50% DDT - 1 lb.	Mc-2017	95.0	1.4	4.8			
	3-6	50% DDT - 1 lb. Oil 1 qt.	Ct- 749	91.3	1.8	8.8			
13	1-6	40% DDT- 1 lb.	Mc-1638	93.5	1.0	6.5			
			Ct- 801	78.0	10.1	21.6			
18	1-6	17% DDT Conc. 8.2 oz.	Mc- 959	84.1	5.4	14.6			
		DDT Combinations							
6	1-2	50% DDT 8 oz. LA 3 lb.							
		L 3 lb.							
	3-6	50% DDT 8 oz. NS 1/2 pt.	Mc-1966	95.3	1.1	4.3	.010	.023	.062
		Oil 2 qt.	Ct-1011	91.8	2.1	7.3			.056
15	1,2,4	50% DDT 8 oz., LA 3 lb.							
		L 3 lb.	Mc-2465	94.2	2.6	4.8	.013	.039	.059
	3,5,6	50% DDT 1 lb.	Ct- 706	77.5	5.6	24.1			.028
5	1-2	50% DDT 1 lb.							
	3-6	DDT 6 oz. - xanthone 12 oz.	Mc-2125	91.5	3.2	7.3			.037
		Kero. 3 pt., Genifilm A & B	Ct- 755	80.8	12.2	14.9			.034

Table 1. Continued

Plot	Covers	Materials 1/ (Amounts per 100 gallons)	Apples per Tree	Apples Clean Percent	Number per 100 Apples Worms	Number per 100 Apples Stings	Harvest Residues 2/ Gr. per lb. As_2O_3	Pb	DDT Average
9	1-6	DDT (17%) Nicotine (7%) 8.2oz	Mc-1744	88.4	3.7	10.4			.029
			Ct- 383	64.1	21.3	31.4			.006
		Ryanex							
14	1-6	Ryanex (100%) 6 lb.	Mc-1462	64.1	5.2	54.1			
			Ct- 612	67.9	8.0	49.5			
		Nicotine (1-2 covers. LA 3 lb, L 3 lb.)							
12	3-6	Zinc-nicotinyl-fluosilicate 3 lb., oil 2 qt.	Mc-3375	86.5	5.8	11.4	.010	.025	
			Ct- 503	57.7	33.0	42.5			
10	3-6	BL 155 3 lb., oil 2 qt.	Mc-1745	73.6	16.1	24.6	.008	.023	
			Ct- 347	45.4	54.5	57.8			
11	3-6	BL Dry Conc. 3 lb., oil 2 qt.	Mc-1789	75.4	16.1	21.2	.008	.023	
			Ct- 772	55.9	40.4	38.1			
8	3-6	NS 1/2 pt. - oil 2 qt.	Mc- 848	67.1	22.2	32.5	.008	.021	
			Ct- 752	49.7	52.4	63.3			

1/ LA = lead arsenate. L = lime. BA = blood albumin (actual bood 25% of total amount used). Oil = Prorex C summer mineral oil emulsified with 8 ounces blood albumin. DDT = dosages shown are for actual amount of DDT in product used, 25% DDT was DuPont's Deenate 25-W, 50% DDT was prepared by micronizing technical grade DDT with 50% Pyrophyllite, 40% DDT = Geigy's AK-40, 17% DDT conc. = Tobacco By-Products' DDT concentrate, DDT-Xanthone used in plot 5 = General Chemicals' DDT-Genicide. DDT (17%)-nicotine (7%) = Tobacco By-Products' DDT-Black Leaf 155.

NS = nicotine sulfate (40%). Kero = kerosene. Genifilm A + B = commercial additives prepared by General Chemical Company, A used at 6 ounces, B at 2 ounces. Zinc nicotinyl-fluosilicate = General Chemicals' nicotine ZF No. 25. BL 155 = Kentucky-By-Products' Black Leaf 155 contains 14% nicotine. BL-dry-conc. = Kentucky-By-Products' Black Leaf Dry concentrate contains 14% nicotine.

2/ Arsenic and lead analyses by A. W. Avens, Division of Chemistry, New York Agricultural Experiment Station. DDT analyses by Division of Insecticide Investigations, U. S. Bureau of Entomology and Plant Quarantine.

Lead arsenate:

Control obtained with the lead arsenate schedules was the lowest of any season on record.

DDT:

Outstanding control was obtained with this material for a second year. In all instances DDT gave better control than lead arsenate or nicotine schedules which have been relied upon for codling moth control in this area during the past several years. Good control was obtained with two commercial and one laboratory-prepared water-dispersible mixtures. All three of these materials left a visible white residue on the harvested fruit, when two applications were applied in August. It is believed that the amount of residue present at harvest would be objectionable in the average season, especially in the case of the 25 percent material. A 50 percent DDT product would seem preferable for use in this area at the present time. The addition of blood albumin to the 50 percent DDT-Pyrophyllite material (Plot 4) caused no apparent loss in the mixtures insecticidal properties and the finish of the fruit was outstanding without visible residue, whereas without it (Plot 2) the finish was dulled by the excessive white visible residue present. Severe leaf scorch occurred on Plot 18 at the time of the first cover spray application, probably due to the combination of the sulfur, used as a fungicide, with the oil used in the DDT and tobacco stem mixtures. One advantage noted with the 17 percent material over that of the other materials was that the tobacco stems left a dark brown deposit which blended into the red finish of the fruit so that objectionable visible residues were not apparent. This same factor was noticed on Plot 9 where 17 percent DDT- 7 percent nicotine material was used. DDT used in conjunction with summer oil (Plots 3 and 6) caused severe leaf injury even though oil applications were delayed 20 days after the sulfur application.

DDT Combinations:

DDT and lead arsenate can be combined in the first cover application so that adequate control is maintained for both codling moth and plum curculio. When nicotine sulfate and oil were used with DDT, as in Plot 6, severe leaf scorch occurred, probably because of the oil-sulfur complex. Mite and spider infestations were too low in these plots to determine the value of xanthone in the formula for their control.

Nicotine:

Zinc-nicotinyl-fluosilicate, used with oil (Plot 12) was more efficient than the standard nicotine mixtures used (Plots 10 and 8). However, more than 50 percent of the fruit cracked on their cheeks, probably due to the fluorine present. Control obtained with Black Leaf Dry concentrate, used at 3 pounds/100 gallons with oil, (Plot 11) compared favorably with that obtained with other nicotine mixtures (Plots 8 and 10).

Spray Experiments - Maxwell Orchard, Milton, N. Y.

In this orchard 9 spray schedules were replicated 4 times on single tree McIntosh plots. Trees were large and not properly headed back. The infestation in this orchard was higher than that in the Woolsey orchard. Early sprays applied prior to the first cover were made by the grower, and consisted of the usual lead arsenate-sulfur applications applied primarily for control of curculio and scab.

Six cover sprays were applied to all plots except number 0 which was left for the purpose of determining the initial injury. Dates of spray applications follow.

Dates		Rainfall Since Preceding Date (Inches)
1st cover	June 6-7	
2nd cover	June 15-16	1.87
3rd cover	June 28	1.87
4th cover	July 9 and 11	1.44
5th cover	August 9-10	13.75
6th cover	August 17-18	0.00
Fruit harvested ...	September 7-8	3.70
	Total	22.63

Treatments tested and results obtained are shown in Table 2.

Table 2. Codling Moth Spray Experiments--Maxwell Orchard - Milton, N. Y. - 1945
Variety - McIntosh

Plot	Covers	Materials 1/ (Amounts per 100 gallons)	Apples: per Tree	Apples: Clean: Percent	Number per 100 Apples: Worms	Number per 100 Apples: Stings	Harvest Residues 2/ Gr. per lb. As_2O_3	Pb	DDT Average
03/	0	No insecticide	397	3.3	134.0	38.0			
		DDT							
22	1-6	50% DDT 1/2 lb.	899	77.1	6.6	25.1			.029
21	1-6	50% DDT 1 lb.	993	87.2	4.3	14.9			.054
20	1-6	50% DDT 2 lb.	962	95.2	1.2	4.6			.103
23	1-6	FE 50% DDT 1 lb.	552	83.3	4.9	18.1			.074
24	1	LA 3 lb., L 3 lb.							
	2-6	33% DDT. Emul. 12.5 oz.	881	79.9	3.7	24.8			.083
		Phenothiazine							
27	1-6	Pheno. 2 lb. Kero 2 qt. BA 8 oz.	792	71.9	20.0	25.2			
28	1-3	Pheno. 2 lb., LA 3 lb.							
	4	LA 3 lb., CS 1/2 lb., L 2 lb.							
	5-6	NS 1/2 pt., oil 2 qt.	785	59.4	23.3	55.8	.042	.092	
26	1-3	Pheno 2 lb., LA 2 lb.							
	4-6	Pheno 2 lb., Kero 2 qt. BA 1/2 lb.	763	66.2	14.9	46.2			
		Lead Arsenate							
25	1-6	LA 3 lb., L 3 lb.	935	35.1	35.6	143.4	.103	.248	

1/ DDT- Dosages shown are for actual amount of DDT in product used. 50% DDT = technical grade DDT micronized with 50% Pyrophyllite, FE 50% DDT = DDT mixed with 50% Fullers Earth, 33% DDT Emul = Naugatauck Chemicals' DDT in 72E synthetic oil emulsion.

LA = lead arsenate. L = lime. Pheno = micronized phenothiazine. BA = Blood albumin actual blood 25% of total. CS = copper sulfate. NS = nicotine sulfate. Oil = Prorex C summer mineral oil emulsified with blood albumin.

2/ Arsenic and lead analyses by A. W. Avens, Division of Chemistry, New York Agricultural Experiment Station. DDT and pehnothiazine analyses by Division of Insecticide Investigations, U. S. Bureau of Entomology and Plant Quarantine.

3/ Unreplicated.

Percent clean fruit on the lead arsenate sprayed plot, No. 25, was the lowest we have ever recorded in Hudson River Valley experimental plots having 6 cover sprays. It is concluded that for most orchards 1 pound DDT/100 gallons of spray will give sufficient control. Control in this instance would have been better had all trees been sprayed with DDT. The DDT emulsion used on Plot 24 left no visible residue on the fruit at harvest, so that finish was superior to that obtained with mixtures of DDT suspended in water, although further tests are desirable before this product is extensively recommended for general use. Phenothiazine sprays (Plots 26 and 28) left an objectionable grayish-green residue to the fruit.

Large Scale DDT Tests Applied by Growers

The DDT used in these tests was Deenate 25-W, at the rate of 1 pound actual DDT per 100 gallons. The sprays were applied by the growers, but advice on the timing of applications was furnished by the experimental workers.

J. R. Clarke & Sons Orchard Tests

This orchard consisted of 160 large trees, mostly McIntosh. All trees were sprayed from the rig by circling each tree with a man in a high tower and another near the ground. At the time of the second cover an inside spray consisting of 7.5 gallons per tree was included. Thirty-three hundred gallons or 20.6 gallons per tree were used at each full application. Codling moth injury the previous season had been severe, and it was not difficult to find at least 150 overwintering larvae on each tree trunk at the beginning of the season. Five cover sprays were applied for codling moth control. Fermate was included in the first cover for a fungicide.

Dates of application and rainfall between dates follow.

Dates		Rainfall Since Preceding Date (Inches)
1st cover	June 1-2	
2nd cover	June 13 (includes inside cover)	1.01
3rd cover	June 22	1.74
4th cover	July 6	1.58
5th cover	August 14	13.75
Date harvested	September 13	5.20
	Total	23.28

As will be noted from Table 3 excellent control of codling moth resulted in this block, although the visible residue present on the fruit at harvest was excessive.

Bait captures from 5 bait traps in the Clarke orchard were compared with captures from the Kaley orchard nearby which had a similar codling moth infestation and carry-over but received a lead arsenate spray schedule. Prior to the application of the first DDT spray, codling moth captures ran higher in the Clarke orchard; whereas after DDT was applied captures in the Clarke orchard dropped below those in the Kaley orchard. Since first-brood adults were not present in numbers prior to July 20, it is concluded that DDT reduced the number of moths present in the trees. Bait traps in the Clarke orchard also captured fewer insects of other species after DDT sprays were applied. A comparison of codling moth captures in the two orchards follows.

Period	Codling Moth Captures	
	Clarke Orchard (DDT)	Kaley Orchard (Lead arsenate)
May 12-June 2	1038	663
June 3-13	24	40
June 14-22	95	266
June 23-July 6	119	510
July 7-August 14	52	190
August 15-28	1	38

E. Stuart Hubbard & Sons Orchard Test

In this orchard two adjacent blocks of trees each consisting of 200 trees were selected for comparison. One block had 6 cover sprays of DDT applied to it while the other received a suggested spray schedule for this area which included lead arsenate, nicotine, oil, and phenothiazine. Spray schedules used and results obtained are shown in Table 3. Sulfur was used with the DDT as a fungicide in the first cover spray. Except for the second cover spray all spraying was done from the rig. Dates of spray applications and rainfall between dates follow.

		Rainfall Since Preceding Date (Inches)
1st cover	May 31 - June 1	
2nd cover	June 12 (inside cover included)	0.92
3rd cover	June 22	2.71
4th cover	July 1	1.02
5th cover	July 30	9.22
6th cover	August 8 - 10	1.45
Date harvested ..	September 10 - 12	5.99
	Total	21.31

Moth captures from 5 bait traps in each block follow. Since the DDT block was surrounded on three sides by orchard, there was a greater leveling off of moth captures throughout the season than in the Clarke orchard. Consequently, differences in captures in the two blocks are not so pronounced as in the Clarke and Kaley orchards.

Period	Codling Moth Captures	
	DDT Block	Regular Block
May 11 to June 1	1019	265
June 2 to 12	18	55
June 13 to 22	129	125
June 23 to July 1	119	126
July 2 to 30	23	28
July 31 to August 10	9	20
August 10 to 28	4	4

Table 3. Large Scale DDT Spray Experiments - Hudson River Valley, 1945
Variety - McIntosh

Orchard & Materials 1/ (Amount per 100 gallons)	Covers	Apples Per Tree	Apples Clean Per-cent	Number per 100 Apples Worms	Number per 100 Apples Stings	Harvest Residues 2/ Gr. per lb. DDT
						Average
J. R. Clarke & Sons orchard, Milton, N. Y.						
25% DDT (Deenate) 1 lb. (actual)	1-5	2382	97.6	0.1	2.5	.035
E. S. Hubbard & Son orchard, Poughkeepsie, N. Y.						
25% DDT (Deenate) 1 lb. (actual)	1-6	1943	95.3	1.2	4.7	.057
Regular Schedule		1952	59.8	28.3	41.5	
LA 3 lb., lime 3 lb., NS 1/2 pt.	1-2					
Phenothiazine 2 lb.	3					
LA 3 lb., lime 3 lb.	4					
NS 1/2 pt., summer oil 2 qt.	5-6					

1/ LA = lead arsenate. NS = nicotine sulfate

2/ Analyses by Division of Insecticide Investigations, U. S. Bureau of Entomology and Plant Quarantine.

Tests of Dusts:

Fifteen dust treatments and one spray treatment were compared in the Moriello orchard near New Paltz, N. Y. All treatments were replicated 3 times, each replicate consisting of approximately 6 trees in a row. Unlike previous seasons buffer rows were not left between plots. The variety present was Cortland. Trees were uniform and medium size.

Except for two commercial materials, the dry ingredients of each dust were mixed by the laboratory personnel in a small Day mixer. The dusts were then placed in a Bean self-mixing orchard duster, and oil atomized into them under 40 pounds pressure.

Dust applications were made early in the morning, generally between 5 and 8 a.m. EWT., with a Niagara Direct Drive orchard duster which developed a wind velocity of 220 M.P.H. at the end of the discharge tube. Approximately 2-1/2 pounds were applied per tree per application. Nine applications, six against first brood worms and three against the second brood, were made during the season. Applications were made at 7 day intervals. Generally, the foliage and fruit were moist at the time of application. Dates of application and rainfall between dates follow:

Dates		Rainfall Since Preceding Date (Inches)
1st dust	June 2	
2nd dust	June 8-9	0.82
3rd dust	June 15	0.26
4th dust	June 22-23	2.49
5th dust	June 29	1.91
6th dust	July 6-7	1.33
7th dust	August 6	7.05
8th dust	August 13	1.27
9th dust	August 20	0.00
Date Harvested ..	September 17 to 19	8.74
	Total	23.87

The sprayed plot, used as a standard of comparison, was given a lead arsenate, nicotine, and oil schedule of 6 cover sprays during the season. Wettable sulfur was used as a fungicide in the first cover spray. Dates of application were June 1, 13, 23, July 3, August 7, and August 16.

Materials used and results obtained in the dust schedules are shown in Table 4. Where talc was used as the carrier, the first dust cover contained 40 percent dusting sulfur.

Table 4. Codling Moth Dust Experiments - Moriello Orchard, New Paltz, N. Y. - 1945
Variety - Cortland

Plot	Covers	Insecticide	Sticker	Carrier	Apples per Tree	Apples Clean Percent	Number Per 100 Apples Worms	Number Per 100 Apples Stings	Harvest Residues 2/ Gr. per lb. As_2O_3	Harvest Residues 2/ Gr. per lb. Pb.
1	1-9	LA 20	oil 2	sulfur 78	717	68.4	20.1	43.8	.019	.045
2	1-9	LA 20	oil 2	talc 78	924	67.1	16.8	53.3	.017	.038
3	1-9	LA 25	oil 2	talc 73	798	76.1	11.2	27.6	.028	.063
4	1-9	LA 30	oil 2	talc 68	1137	77.3	8.0	30.6	.047	.103
5	1-9	LA 20+NB 10	oil 2	talc 68	836	76.0	9.7	30.1	.025	.055
6	1-9	LA 20+NB 10	oil 2	talc 58+L 10	832	67.7	12.5	43.2	.025	.058
7	1-9	LA 20+NB 20	oil 2	talc 58	756	79.8	7.7	23.9	.023	.052
8	1,2,3,7,8	LA 20+NB 10	oil 2	talc 58+L 10					.023	.050
	4,5,6,9	LA 20	oil 2	talc 78	809	68.7	18.3	42.6		
9	1-9	Pheno 20	oil 2	talc 78	853	89.9	6.1	8.4		
10	1-9	LA 20+Pheno 10	oil 2	talc 68	651	91.9	3.2	9.5	.016	.045
11	1-9	DDT 5	None	talc 95	826	90.9	8.9	12.5		
12	1-9	DDT 5	oil 2	talc 93	742	94.3	2.1	4.8		
15	1	LA 30	None	sulfur 70						
	2-9	LA 20	oil 4	talc 76	741	70.1	12.7	46.9	.029	.066
14	1-9	Com. #1	--	- - - -	886	65.1	17.2	49.1	.023	.060
16	1-9	Com. #2	--	- - - -	933	53.6	31.0	93.5	.017	.039
13	1-6	Spray			870	85.6	3.7	18.2	.016	.045

1/ LA = lead arsenate. Oil = Prorex D dormant oil (100 viscosity). Sulfur = Corona dusting sulfur. Talc = Eastern Magnesium Co. No. 23. NB = Black Leaf 155 (nicotine 14%). L= lime. Pheno = micronized phenothiazine. Com. #1=Niagara Kolo M-551 dust containing 30% lead arsenate and 20% bentonite, sulfur. Com. #2 = Corona 30% lead arsenate 70% sulfur dust. Spray = 1 + 2 covers LA 3 lbs.- L 3 lb.-NS 1/2 pt.-sulfur in 1st cover, 3, 5, + 6 covers - NS 1/2 pt.- oil 2 qt.., 4th cover - LA 3 lb.- L 3 lb.

2/ Arsenic and lead analyses by A. W. Avens, Division of Chemistry, New York Agricultural Experiment Station. DDT and phenothiazine analyses by Division of Insecticide Investigations, U. S. Bureau of Entomology and Plant Quarantine.

Oil was used in nearly all laboratory-prepared dusts as a sticker, since tests in previous seasons had shown the inclusion of oil increased the adhesive properties of the dust and the control obtained. Differences between the control obtained with a 4 percent oil (Plot 15) and a 2 percent oil (Plot 2) are somewhat misleading, since a study of the plot layout showed that the Plot 15 replicates were in the heavier infested areas of the orchard. DDT residues were less than 0.01 grain per pound of fruit, even where oil was used as a sticker.

Where the talc was used as a carrier with lead arsenate no burning typical of sulfur or sulfur-oil injury appeared, but moderate to severe arsenical injury occurred on the foliage, the amount of burning seeming to increase with the increase in the amount of lead arsenate or oil used in the formula. Such injury on plots where sulfur was used was very light. When phenothiazine was combined with lead arsenate and talc, arsenical injury was prevented. Lime could probably be used to replace a part of the talc and would serve as a corrective for the arsenical injury.

In the DDT plots (11 and 12), the foliage and fruit finish was excellent. To date the DDT dusts are the most satisfactory of any dusts tested for codling moth control. Since DDT sprays were not used in the dust experiments direct comparisons between control obtained and dusting DDT are not available. It is assumed that in most instances sprays would have been more effective.

Laboratory Investigations Relative to the Effect of Nicotine and DDT Sprays and Dusts on Adults

Moths used in these experiments were reared from worms collected in the field in the fall of 1943 and stored at about 32 to 35 degrees F. until January 1945. At that time they were placed in a controlled temperature room at 75 degrees F and 60 - 65 percent relative humidity and allowed to emerge in large cloth covered cages. For treatment they were collected from the rearing cages and placed in small wire screen cages. These cages were then sprayed in a precision spray cabinet with a DeVilbiss WDA paint spray gun at 30 pounds of air pressure with the liquid valve open 2 turns. After treatment and in the same cages they were placed in the temperature-controlled room where observations were made every 24 hours. Cages which had been sprayed with DDT materials were washed in kerosene and then in soap and water before being used again. No attempt was made to feed the moths either in emergence or test cages.

Although the results of these experiments are somewhat erratic, and there was an unusually high mortality in the water-sprayed checks, certain conclusions are at least indicated. The toxicity of DDT to the moths and the rapidity with which it kills seems to vary with the way in

which it is used. A micronized mixture of 50 percent DDT in Pyrophyllite kills slowly and is less effective than the same concentration used with a suitable wetting agent. DDT dissolved in oil and used as an emulsion is especially effective and kills more rapidly than the suspended materials. When two quarts of summer oil were added to a DDT suspension, the rate of kill and final toxicity were increased considerably. Nicotine, as used in these tests, was less effective than DDT but its effectiveness was greatly increased when a wetting agent was added.

Studies of the Use of Chemicals to Destroy Hibernating Worms

No injury was noticed in trees sprayed with a commercial dinitro-ortho-cresol trunk spray applied March 30. The material was used at the rate of 1 gallon to 100 gallons of spray in conjunction with 15 gallons kerosene and 1 pint ferric chloride solution (1 ounce/1 gallon). The formula for the dinitro-ortho-cresol solution was as follows:

4,6 dinitro-ortho-cresol	37 percent
Phthalic glycerol alkyd resin	6 percent
Inert ingredients	57 percent

Better than 96 percent of the larvae were killed on sections of logs sprayed at the same time/the sprays were applied; as compared to 5 percent on unsprayed logs.

European Red Mite and DDT Sprays, Poughkeepsie, N. Y., 1945

R. W. Dean, New York Agricultural Experiment Station, Division of Entomology, Hudson Valley Fruit Investigations Laboratory.

To date, there has been no alarming build-up of European red mites where DDT sprays were used in Eastern New York. A series of test blocks were sprayed with DDT, alone and combined with various acaricides, in comparison with the standard spray schedule and with sprays recommended for red mite control. From three to six covers were applied, the mite control program being started in the third cover spray. The mite population was sampled at 10 to 14 day intervals from June 1, before treatment started, to October 15. Red mite had started to build up in the orchard and some injury was noticeable before the tests were started. However, before the third cover spray was applied, a marked decrease in mites occurred, due to natural causes other than insect predators. This decrease occurred in all plots, including those sprayed with DDT. It is, therefore, impossible to evaluate the treatments. There was a small increase in numbers of mites in the DDT plot late in the season. Similar increases occurred in most plots in which an effective acaricide was used, but was lacking in the check. At least part of this increase is attributed to the better condition of the foliage in sprayed plots in late summer. That on the unsprayed check trees was in too poor condition to attract mites by that time.

In the J. R. Clarke and Sons orchard used for a large scale codling moth test of DDT, a late-season mite outbreak was noted. The species chiefly responsible was the common red spider mite, Tetranychus sp. This is the first instance, noted by the writer, of an infestation by this mite on apple trees in the Hudson Valley area. European red mites were also present but in small numbers. The infestation developed about a month after the application of the last DDT spray and was too late in the season to cause serious damage.

Apple Maggot Investigations - Poughkeepsie, New York, 1945

R. W. Dean, New York Agricultural Experiment Station, Division of Entomology, in Cooperation with the U. S. Department of Agriculture, Agricultural Research Administration, Bureau of Entomology and Plant Quarantine, Division of Fruit Insect Investigations.

Three applications of DDT spray gave satisfactory control of apple maggot under light crop conditions, which tend to accentuate injury. The materials used were GNB-A DDT- Pyrophyllite (1:1 micronized) 2 pounds plus micronized wettable sulfur 4 or 5 pounds per 100 gallons. They were applied in the second, third and fourth covers - June 25, July 7 and July 20. Examination of all fruit from six trees revealed from 0 to 8.72% injury, the average being 2.31%. In 1944 the average of infested fruit was 25.34%. DDT residues on the earliest harvested fruit, Duchess picked August 8, was 0.004 grains per pound of fruit.

A schedule combining lead arsenate and phenothiazine failed to give adequate protection to large trees which could not be covered adequately. The materials used were as follows:

First cover (applied by grower) - Lead arsenate, lime, wettable sulfur nicotine sulfate.
Second cover (applied by grower) - Same as first cover.
Third cover (first maggot spray) - Micronized phenothiazine 2 pounds, wettable sulfur 4 pounds - June 26.
Fourth cover - Fixed nicotine 3 pounds, wettable sulfur 4 pounds - July 6.
Fifth cover (second maggot spray) - Lead arsenate 3 pounds, hydrated lime 3 pounds, wettable sulfur 6 pounds - July 20.

Counts of all fruit from four trees showed injury ranging from 29.21% to 80.05%, the average being 51.22%. The exact infestation in 1944 is not known but it was heavy. Spray residues on McIntosh apples picked September 21 were 0.024 grains AS_2O_3 and 0.071 grains Pb. per pound of fruit.

YAKIMA, WASHINGTON

E. J. Newcomer, In Charge (Fruit Insect Investigations),
and W. E. Westlake (Insecticide Investigations).

Seasonal Conditions

Full bloom of apples was one day later than in 1944 and the calyx spray was put on at the same time. Cooler weather delayed the cover sprays a few days. The summer was about normal, but cooler weather in September stopped worm activity earlier than in 1944.

Biological Observations

Emergence of moths from overwintering larvae started late in April, reached a peak May 28-30, and continued throughout June. First-brood moths began emerging in July, reached a peak shortly after the middle of August, and emerged at a considerably reduced rate after that. About 31,000 moths were caught in five baits as compared with about 29,000 in 1943 and 41,000 in 1944.

Orchard Spraying Experiments

Spraying experiments were made in two orchards in 1945, a Rome orchard in which most of the tests were repeated twice, and a Winesap orchard in which a single series was run. Single-tree plots were used, replicated 8 times in each experiment. From each tree random samples of 250 apples were taken at harvest, including both picked and dropped fruit. A calyx spray of 2 pounds of lead arsenate to 100 gallons was used in all of the experiments. Six cover sprays were applied in the Rome orchard between May 25 and August 18, and seven cover sprays were applied in the Winesap orchard between May 23 and August 22.

The spraying experiments included chiefly tests of half-strength DDT (1/4 lb. to 100 gal.) in combination with half-strength lead arsenate, cryolite, xanthone, and nicotine bentonite, compared with full-strength materials; wettable DDT powders with and without a dinitro compound to control mites; a test of DDT dissolved in oil; and a small test of zinc nicotinyl fluosilicate.

Spray Deposits

Deposit analyses were made for each major treatment before and after the first to sixth cover sprays, inclusive, on the Romes, and before and after the first, fourth, sixth, and seventh cover sprays on the Winesaps, with a few exceptions. The averages of these are shown in table 1.

Table 1. Average spray residues expressed in micrograms per square centimeter. Yakima, Washington - 1944

Treatment 1/	Residue	Rome		Winesap	
		Before spray	After spray	Before spray	After spray
1	AS_2O_3	18.2	34.1	24.0	34.7
2	AS_2O_3	12.0	19.1	13.1	19.9
	DDT	8.2	11.3	9.7	14.7
3	Fluorine	39.4	58.3	41.0	67.6
4	Fluorine	27.6	39.5	37.6	51.1
	DDT	7.4	9.8	10.3	15.5
5	Xanthone	10.9	26.6	14.7	41.3
6	Xanthone	2.6	14.1	3.1	14.7
	DDT	6.3	9.5	5.7	10.1
7	Nicotine	3.0	5.6	3.7	6.9
8	Nicotine	1.7	3.4	1.8	3.7
	DDT	6.7	9.6	10.7	12.1
9	Nicotine	4.7	8.4	5.7	10.2
10	DDT	6.7	9.5		
11	DDT	6.5	10.2		
12	DDT	6.8	11.1		
13	DDT	6.7	12.0		
14	Nicotine	6.5	11.6		
15	DDT	19.9	42.8		

1/ For details of treatment, see table 2.

The average deposits of AS_2O_3 and fluorine were similar to those of 1944. The deposits of xanthone after spraying were less than those of 1944 in the Rome orchard and higher in the Winesaps. Nicotine deposits with Black Leaf 155 and tank-mix nicotine bentonite compared favorably with those resulting from the use of micronized dry-mix nicotine bentonite in 1944.

Control Results: The results of the field spraying experiments are given in table 2, and the average numbers of apples per box are given in table 3. Plats 1 to 9, which were repeated three times, consisted chiefly of tests of previously used materials compared with half strengths of those same materials to which half-strength DDT was added. Plats 10 to 13, made only once, consisted of various tests of DDT, and plat 14 of a new nicotine compound.

Cryolite: As in previous years, cryolite (3) gave results that on the whole did not differ greatly from lead arsenate (1), although in one Rome orchard there were significantly fewer worms, and in the Winesap orchard both the worms and stings were significantly greater. The Winesap apples were also smaller, but the Romes did not differ materially.

Xanthone: This year there were fewer wormy apples in the xanthone plats (5) in the Rome orchard than in the lead arsenate ones (1), a condition that has not occurred previously, but there was no such difference in the Winesaps. Total injuries were significantly less in all three plats. The Winesaps sprayed with xanthone were reduced in size and the Romes were slightly smaller.

Nicotine: A commercial nicotine bentonite (Black Leaf 155)(7) resulted in significantly more wormy fruit in two of the three plats than in the lead arsenate ones (1), but in terms of injured fruit the difference was significant only in the Winesaps. Mississippi bentonite was used in the tank-mix nicotine bentonite (9), as this had given better results than Wyoming bentonite in Indiana. Last year there was no significant difference between lead arsenate and nicotine bentonite made with the Wyoming bentonite, except that there were fewer stings on Winesaps sprayed with the latter. This year, the results were somewhat erratic with the Mississippi bentonite. In Orchard A there were significantly fewer total injuries, but in Orchard B and in the Winesap orchard the number of wormy apples was significantly greater. There was no effect on the size of Romes, as compared with lead arsenate, but the Winesaps were smaller. As a matter of fact, the Winesaps in the lead arsenate plat may have been abnormally large, since they averaged larger than in any of the other treatments.

A zinc nicotinyl fluosilicate was used on four trees in plat 14, with mineral oil, oleic acid and aluminum sulfate. Although the control was good, there were some drawbacks. An injury to the fruit appeared late in June consisting of small sunken black areas. A check on this showed that it was caused by the combination of the fluosilicate and oil and did not occur if oil was not used. At harvest about 16 percent of the fruit showed this injury and the fruit was exceedingly small (table 3).

DDT: In the plats where half-strength DDT was used with half-strength lead arsenate (2) and half-strength cryolite (4), there was a very marked and significant reduction in both worms and stings as compared with full strength of the latter materials (1 and 3); and the results in 2 and 4 were equally good.

In plat 6 a commercially prepared mixture of DDT and xanthone was used, after the 2nd cover spray, and there was no significant difference between this and the straight xanthone (5), except in the wormy apples in the Winesap plat. This was apparently due to the unexpectedly small quantity of xanthone deposited by this combination (see table 1). In the other combinations the deposits of arsenic, fluorine and nicotine were nearly always more than half those from the full-strength materials, but the deposit of xanthone was usually much less than half.

Table 2. Comparative efficiency of insecticides used in field spraying experiments. Yakima, Wash., 1945

No.	Treatment (quantities are for 100 gallons) 1/	Orchard A Rome		Orchard B Rome		Orchard C Winesap	
		% Wormy	% Injured	% Wormy	% Injured	% Wormy	% Injured
1	Lead arsenate 3 lb., mineral oil (emulsive) 1 qt., 2/ Colloidal 77, 1/6 lb.	10.5	23.9	25.6	43.2	15.0	52.8
2	DDT 4 oz., 3/ lead arsenate 1.5 lb., oil and spreader as in 1	0.8	5.2	4.6	15.4	8.2	30.9
3	Cryolite 3 lb., mineral oil (emulsive) 1 qt., 2/ Colloidal 77, 1/6 lb.	8.4	22.4	13.8	40.9	24.2	61.6
4	DDT 4 oz., 3/ cryolite 1.5 lb., oil and spreader as in 3	2.2	12.6	2.2	12.9	6.5	27.8
5	Xanthone 2 lb., Colloidal 77, 1/2 lb., stove oil 1 qt. (commercial nicotine bentonite as in 7, 1st and 2nd cover sprays)	5.8	9.0	11.0	17.2	19.4	29.9
6	DDT 4 oz., 4/ xanthone 1 lb., spreader and oil as in 5. (commercial nicotine bentonite and DDT as in 8, 1st and 2nd cover sprays)	4.2	11.6	8.0	23.8	8.9	24.2
7	Commercial nicotine bentonite (Black Leaf 155) 2 lb., mineral oil 1 qt., oleic acid 4 oz., aluminum sulfate 2 oz.	19.8	29.1	31.6	42.7	37.8	64.2
8	DDT 4 oz., 5/ commercial nicotine bentonite 1 lb., oil, etc., as in 7	2.0	8.9	7.8	24.2	6.8	31.7

Table 2. (Continued)

No.	Treatment (quantities are for 100 gallons) 1/	Orchard A Rome % Wormy	Orchard A Rome % Injured	Orchard B Rome % Wormy	Orchard B Rome % Injured	Orchard C Winesap % Wormy	Orchard C Winesap % Injured
9	Nicotine bentonite (tank mix) 1:5, 3 lb., 6/ mineral oil 1 qt., oleic acid 4 oz., aluminum sulfate 2 oz.	9.8	13.0	35.7	42.8	32.0	52.7
10	DDT 4 oz. dissolved in 225 cc. benzol and then in 2 qt. mineral oil (emulsive)	3.9	16.9	--	--	--	--
11	Same as 12. DN-111 used at 1/2 lb. in 4th cover and 1/3 lb. in 5th cover sprays	3.0	11.6	--	--	--	--
12	DDT (du Pont tech. 1945) 8 oz., Pyrax 1.5 lb. (pre-mixed)	1.6	5.6	--	--	--	--
13	DDT (Geigy tech. 1944) 8 oz., Pyrax 1.5 lb. (pre-mixed)	0.8	3.5	--	--	--	--
14	Zinc nicotinyl fluosilicate 2 lb., mineral oil, etc., as in 9	3.9	10.3	--	--	--	--
15	DDT 2 lb. (5 lb. AK 40)	0.4	2.8	--	--	--	--
	Differences required for significance (19:1)	4.0	6.7	8.3	10.5	5.2	8.1

1/ Calyx spray, lead arsenate 2 lb. to 100 gal. in all treatments.
2/ Increased to 2 qt. in 2nd and 3rd cover sprays.
3/ In plots 2 and 4 du Pont Deenate-25W containing 25% DDT was used at 1 lb. to 100 gal.
4/ In plot 6 a mixture of xanthone and DDT prepared by the General Chemical Co. was used.
5/ In plot 8 a mixture of Black Leaf 155 and DDT prepared by the Tobacco By-Products and Chemical Corp. was used.
6/ 1 lb. Black Leaf 40 and 5 lb. Mississippi X-110 bentonite.

Table 3. Size of apples resulting from spray treatments. Yakima, Wash., 1945

Plot		Size (ave. no. apples per orchard box) Rome A	Rome B	Rome average	Winesap
1	Lead arsenate 3 lb.	110	105	108	129
2	DDT-Lead arsenate	136	115	125	149
3	Cryolite 3 lb.	115	109	112	155
4	DDT-Cryolite	114	147	127	158
5	Xanthone 2 lb.	120	113	116	150
6	DDT-Xanthone	106	117	111	146
7	Comm. nicotine bentonite 2 lb.	99	115	106	144
8	DDT-nicotine bentonite	130	123	127	139
9	Nicotine bentonite 1:5 (tank mix)	109	112	110	137
10	DDT-Mineral oil	118 2/	---	---	---
11	DDT-DN-111	106	---	---	---
12	DDT, 1945	117	---	---	---
13	DDT, 1944	135 3/	---	---	---
14	Zinc nicotinyl fluosilicate 2 lb.	190 2/	---	---	---

1/ For details of treatment, see table 2.

2/ Four trees only.

3/ Seven trees only.

In plot 8, where a commercially prepared mixture of DDT and Black Leaf 155 was used, results were uniformly much better than from the Black Leaf 155 alone or the tank-mix nicotine bentonite.

All of these tests of DDT in combination with other materials gave very similar results which did not differ significantly from each other. The development of mites and woolly aphis was very great in the combinations with lead arsenate, cryolite and nicotine, but neither pest was of any consequence in the combination with xanthone. As a result of the mite infestation the apples in plots 2, 4 (except Orchard A) and 8 were smaller than in the other plots. In plot 4, Orchard A, an application of DN-111 was made July 31 which stopped the mites and allowed the fruit to size normally. Many of the apples in plots 2 and 8 were also less highly colored. Since there were few mites in plat 6, the fruit was as large as in plot 5. This was thus the best all around treatment used.

Treatments 10, 4 ounces of DDT dissolved in oil, gave good results, but the use of 2 quarts of oil in each cover spray did not prevent the mites or aphids from developing. In plot 11, the addition of DN-111 to the sprays applied July 2 and 25 stopped the development of the mites and resulted in larger fruit, although the woolly aphids became very numerous. Treatments 12 and 13 were compared to see if any differences in the two lots of DDT would show up. There were fewer worms in 13, but the difference was not significant, and the apples were smaller, the reason for this not being evident. The dead areas in the apple leaves, reported in 1944, showed up again this year wherever mites were abundant, even on trees not sprayed with DDT, but they were not evident in plots 6 or 11 where DDT was used but where the mites were scarce. This injury is thus correlated with mite abundance and not with presence of DDT.

In treatment 15 DDT was used at 2 pounds per 100 gallons, but although the mites were less numerous on these trees than on others there were still too many of them and the woolly aphids became very numerous. No check on size of fruit was possible, as only two trees were used.

Use of Sprays to Kill Hibernating Codling Moth Larvae on Trunks: Large-scale orchard tests were made in three orchards in 1945. Sprays were applied March 24 to April 2, using a regular portable gasoline-power sprayer, with one exception, and maintaining a pressure of around 300 pounds. Spray guns were used equipped with No. 3 disks. Approximately 3.8 gallons of spray was used per tree. As usual, an attempt was made to cover the trunks and most of the rough bark part of the scaffold limbs. Examinations for kill were made 2 to 3 weeks after spraying.

The "regular" formula (with the penetrant) was used in all three orchards, and in addition a quick-breaking formula was used in one of them with Celite 209 as a penetrant aid.

The formulas and the kills obtained are shown below:

	Percent kill in orchard		
	A	B	C
Regular DNOC formula: DNOC 4 lb. Stove oil 10 gal. Triton B-1956 4 pints Ethylene glycol monobutyl ether 1-1/2 gal. Trichloroethylene 1-1/2 gal.	80	87	88
Quick-breaking DNOC formula: DNOC 4 lb. Stove oil 15 gal. Triton B-1956 1/2 pint Celite 209 3 lb. Hydrochloric acid 1-1/2 pints.		78	

The kills in these tests were somewhat below those usually obtained. This may probably be due to any one or more of three factors: the use of guns, higher pressure than usual with the consequent greater haste, and to a sprayman inexperienced in doing this type of spraying. The spray was just as effective as ever but the application evidently was not. The kill on the trunks and lower scaffold limbs for the regular formula in all three orchards averaged 95 percent compared with 72 percent on the upper sprayed parts of the scaffold branches.

The results of these large-scale tests in control at harvest time are shown below:

Orchard		Variety	Percent wormy (harvest)	
			Sprayed	Check
A	Regular (penetrant)	Winesap	27.1	21.4
B	Regular (penetrant)	Winesap	10.4	
	Revised (Celite)	Winesap	18.8	22.7
C	Regular (penetrant)	Winesap	13.4	23.4
	Regular (penetrant)	Jonathan	32.5	54.8

In all tests except orchard A there was an apparent increased control where the trunk sprays were applied. In orchard A, however, where the original infestation was already greatest in the spray plot and the check plot was always sprayed by the grower first and more nearly on time, any benefit from the trunk spray was not evident.

No injury has ever been observed to the trunks and scaffold limbs of average size apple trees. The trunks of a few smaller Winesap, Delicious, and Bartlett pear trees have also been sprayed without apparent injury.

Summer Test of Trunk Spray: A summer test was made of the regular dinitro-o-cresol, containing the penetrant, the quick-breaking formula, and of two DDT formulas. On July 14 the trunks and scaffold limbs of 6 fruitless Jonathan trees were sprayed with each of these four formulas. Six similar trees were left as checks. A few days later 75 to 200 full-grown larvae were placed on each of one half of these trees. The sprayed surfaces were examined twice each week for live and dead larvae and empty pupal cases. On August 27, after 42 days, the bark chips were removed and the final examination was made. On August 14, 30 days after the trunks had been sprayed, about 200 larvae were placed on each of the other three trees in each treatment and on the three other check trees. This second series of trees was also examined semi-weekly until September 24, when it was examined like the first lot. The results are shown on the following page.

Formula (Per 100 gallons of spray)	Percent of larvae dead	
	First Period	Second Period
DNOC (Regular formula with penetrant)	91.5	93.6
DNOC (Quick-breaking formula with Celite, 2 lb.)	81.3	85.8
DDT 4 lb. in 10 gal. stove oil, 1/2 pt B-1956, Celite 209, 2 lb.	47.6	31.6
DDT (AK 40) 10 lb.	27.3	24.2
Check	23.0	9.7

It is apparent from this test, and that made in 1944, that a summer application of a DNOC trunk spray, particularly the formula containing the penetrant, will kill most of the full-grown larvae entering the sprayed surfaces for 70 to 90 days after its application to the tree bark. Neither DDT formula showed much promise.

Test of Repellent Against Mature Larvae: On July 5, ten badly infested trees in a single row were sprayed on their trunks and scaffold limbs to a height of 6 to 7 feet, using the following formula: pyrethrum extract (Pyrocide 20) 2 percent, cottonseed oil 5 percent, and blood albumen emulsifier 2 ounces to 100 gallons of water. About 2 gallons of spray was used per tree. The rough bark was left on the tree except for a narrow ring around the trunk where a double beta naphthol band was placed, one outside the other. The band against the bark was placed with the smooth side against the tree. As a check against this test the adjacent row of 10 similar trees was similarly banded but no repellent spray was applied. On November 15 the bands were collected and the number of larvae counted. The repellent-sprayed trees averaged 1,031 larvae per double band compared with 900 for the unsprayed check trees, or a difference of about 15 percent in favor of the repellent-sprayed trees. However, these results are not conclusive since the sprayed trees may have had more worms than the checks.

KEARNEYSVILLE, WEST VIRGINIA

James F. Cooper, Bureau of Entomology and Plant Quarantine, United States Department of Agriculture and Edwin Gould, West Virginia Agricultural Experiment Station.

These investigations were carried on jointly by the Bureau of Entomology and Plant Quarantine and the West Virginia Agricultural Experiment Station.

Seasonal Conditions and Codling Moth Activity

The winter of 1944-45 was favorable for codling moth survival and larval mortality was low. Unusually warm weather during March, when the mean temperatures averaged 12 degrees above normal, advanced vegetation and insect development almost a month ahead of normal. Peaches had passed full bloom in this area and some apple varieties were beginning to bloom by April 1. Subfreezing temperatures on the nights of April 5 and 6 (29° F.) and again on May 1 (28° F.) resulted in heavy fruit kill. The peach crop was reduced to approximately 60 percent and the apple crop to 30 percent of normal.

The season was unfavorable for adult codling moth activity. Alternate warm and cool periods during the spring brood resulted in light egg deposition with the result that despite the very heavy codling moth population carried over from 1944 and the light crop, first brood damage was not unusually severe. Second brood activity was light.

Pupation of overwintering codling moth larvae had reached 23 percent on March 31 and the first adult moth emergence was noted on April 10. Emergence of spring brood moths continued until June 16 with 15 percent out by April 30, 45 percent by May 15 and 89 percent by June 1. First worm entries were noted on May 16 and the first exits on June 15.

Bait pail collections reached a peak on May 14. Three periods of sharp activity of spring brood moths were recorded in the pails; April 29-May 1, May 12-16 and May 19-23. The total spring brood bait pail collections in 1945 was nearly twice as great as in 1944, despite the fact that collections were reduced in 3 of the 4 orchards in which pails were located by the mothicide effect of DDT sprays. Ninety-two percent of the season's total moth catch was taken during the spring brood.

The growing season of 1945 was generally favorable for apples. Rainfall was above normal for five of the six months from April through September. This helped increase fruit size but was not favorable for good coloring.

Field Tests of Insecticides

A block of approximately 20 acres of Jonathan trees located within a 180-acre orchard about 7 miles northwest of Martinsburg, W. Va., was selected for the 1945 field tests. A fairly heavy codling moth population was present in the selected orchard.

The selected block was divided into two parts which will be referred to as Block A and Block B. Schedules compared in Block A were based around lead arsenate and those in Block B on DDT. Fungicides were used throughout the season in Block A but none were used in Block B after the delayed petal-fall application.

Tests were started with the first cover spray prior to which the only spray applied in this orchard was a delayed petal-fall application of lead arsenate, lime and lime sulfur. Seven cover sprays were applied to all plots during the season on the following dates.

First brood covers	Second brood covers
1st - May 7-12	5th - July 9-12
2nd - May 21-25	6th - July 25-26
3rd - June 11-13	7th - Aug. 13-14
4th - June 26-27	

First brood fruit injury counts were made early in July and harvest counts between September 11 and 22. Fruit drop was very light during the season until immediately prior to harvest and only two dropped fruit counts were taken, the first in conjunction with first brood counts in July and the second in conjunction with harvest.

Following is a list of materials used and explanation of symbols used in the tables:

ZnS - zinc sulfate
CuS - copper sulfate
L - lime, hydrated spray
LA - lead arsenate (Orchard Brand)
Phenothiazine - micronized unconditioned phenothiazine
Flot. Sul. - Flotation sulfur
Fermate - ferric dimethyl dithiocarbamate
Oil - summer oil emulsion - 83% oil
DDT - dichloro diphenyl trichloroethane - amounts indicate the quantity of actual DDT used. In Block A the appropriate amount of the 25% DDT commercial formulation K was used to provide the amounts given in the tables.

In the tables the first line of figures are the first brood infestation count results and the second lines are the season's total including harvest and all dropped fruit.

Table 1. Block A - Group 1 - Lead Arsenate Schedules

Plot No.	Cover Sprays	Materials per 100 gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits	
					Worms	Stings
1	1	1/2# ZnS, 2# L, 3# LA				
	2,3,5,6 & 7	1/2# CuS, 2# L, 3# LA	48.7	3.4	4.1	91.8
	4	2# CuS, 4# L, 3# LA	25.8	11.2	16.5	183.4
2	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	1/2# CuS, 2# L, 4# LA				
	4	2# CuS, 4# L, 4# LA	46.5	4.9	6.0	93.0
	5,6 & 7	1/2# CuS, 2# L, 3# LA	30.5	7.8	10.0	156.3
10	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	1/2# CuS, 2# L, 6# LA				
	4	2# CuS, 4# L, 6# LA	62.0	1.2	1.2	62.8
	5,6 & 7	1/2# CuS, 2# L, 3# LA	38.7	4.5	6.1	136.1
3	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	1/2# CuS, 2# L, 4# LA, 3 qt. "Orthol-K" oil				
	4	2# CuS, 4# L, 4# LA	81.6	0.4	0.4	23.6
	5,6 & 7	1/2# CuS, 2# L, 3# LA	54.3	2.9	3.9	75.0
4	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	1/2# CuS, 2# L, 4# LA, 3 qt. "Hy-Tox" oil				
	4	2# CuS, 4# L, 4# LA	76.5	0.6	0.6	33.7
	5,6 & 7	1/2# CuS, 2# L, 3# LA	56.5	3.3	4.5	75.6
5	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	4# LA, 3 qt. "Orthol-K" oil, no fungicide or safener				
	4	2# CuS, 4# L, 4# LA	86.9	0.2	0.2	16.3
	5,6 & 7	1/2# CuS, 2# L, 3# LA	67.1	1.9	2.4	48.0
8	1	1# "Fermate," 3# LA				
	2,3 & 4	2# phenothiazine, 3# LA	84.1	0.8	0.8	18.2
	5,6 & 7	1/2# CuS, 2# L, 3# LA	42.3	16.1	24.6	96.6
9	1	8# Flot. Sul., 3# LA				
	2,3 & 4	2# phenothiazine, 3# LA	90.5	0.7	0.7	9.6
	5,6 & 7	1/2# CuS, 2# L, 3# LA	50.9	13.8	22.1	77.6

Table 2. Block A - Group 2 - DDT-Lead Arsenate Combination Schedules

Plot No.	Cover Sprays	Materials per 100 gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits	
					Worms	Stings
11	1	1/2# ZnS, 2# L, 3# LA, 1/2# DDT				
	2,3,5,6 & 7	1/2# CuS, 2# L, 3# LA	45.6	5.7	6.3	109.4
	4	2# CuS, 4# L, 3# LA	25.6	12.0	18.2	195.8
12	1	1/2# ZnS, 2# L, 3# LA				
	2	1/2# CuS, 2# L, 3# LA, 1/2# DDT				
	3,5,6 & 7	1/2# CuS, 2# L, 3# LA	52.2	3.0	3.3	85.0
	4	2# CuS, 4# L, 3# LA	28.1	8.5	11.5	163.9
13	1	1/2# ZnS, 2# L, 3# LA				
	2,5,6 & 7	1/2# CuS, 2# L, 3# LA				
	3	1/2# CuS, 2# L, 3# LA, 1/2# DDT	76.8	1.4	1.6	30.2
	4	2# CuS, 4# L, 3# LA	45.1	12.7	21.4	128.2
14	1	1/2# ZnS, 2# L, 3# LA				
	2,3,5,6 & 7	1/2# CuS, 2# L, 3# LA	53.0	1.2	1.2	85.2
	4	2# CuS, 4# L, 3# LA, 1/2# DDT	30.3	9.4	13.2	148.1
15	1	1/2# ZnS, 2# L, 3# LA, 1/2# DDT				
	2,5,6 & 7	1/2# CuS, 2# L, 3# LA				
	3	1/2# CuS, 2# L, 3# LA, 1/2# DDT	79.0	1.0	1.2	24.8
	4	2# CuS, 4# L, 3# LA	46.9	7.3	10.9	90.0
16	1	1/2# ZnS, 2# L, 3# LA				
	2	1/2# CuS, 2# L, 3# LA, 1/2# DDT				
	3,5,6 & 7	1/2# CuS, 2# L, 3# LA	73.2	0.2	0.2	36.5
	4	2# CuS, 4# L, 3# LA, 1/2# DDT	52.4	4.7	7.1	74.0
17	1	1/2# ZnS, 2# L, 3# LA, 1/2# DDT				
	2 & 3	1/2# CuS, 2# L, 3# LA, 1/2# DDT				
	4	2# CuS, 4# L, 3# LA, 1/2# DDT	93.4	0.1	0.2	8.0
	5,6 & 7	1/2# CuS, 2# L, 3# LA	67.1	5.5	7.4	43.3
18	1	1/2# ZnS, 2# L, 3# LA, 1/4# DDT				
	2 & 3	1/2# CuS, 2# L, 3# LA, 1/4# DDT				
	4	2# CuS, 4# L, 3# LA, 1/4# DDT	83.3	0.3	0.3	22.4
	5, 6 & 7	1/2# CuS, 2# L, 3# LA	50.0	9.8	14.5	98.7
19	1	1/2# ZnS, 2# L, 1 1/2# LA, 1/2#DDT				
	2 & 3	1/2# CuS, 2# L, 1 1/2# LA, 1/2# DDT				
	4	2# CuS, 4# L, 1 1/2# LA, 1/2# DDT	89.2	none	none	12.6
	5,6 & 7	1/2# CuS, 2# L, 3# LA	56.6	7.4	10.6	62.2

Table 2. (Continued)

Plot No.	Cover Sprays	Materials per 100 gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits Worms	Per 100 Fruits Stings
6	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	1/2# CuS, 2# L, 3# LA				
	4	2# CuS, 4# L, 3# LA	53.2	1.9	1.9	74.8
	5,6 & 7	1/2# CuS, 2# L, 3# LA, 1/2# DDT	41.7	1.7	1.8	101.2
7	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	1/2# CuS, 2# L, 3# LA				
	4	2# CuS, 4# L, 3# LA	52.8	5.7	6.7	89.9
	5,6 & 7	1/2# DDT, 3 qt. "Orthol-K" oil	43.1	4.1	5.7	118.9
20	1	1/2# ZnS, 2# L, 3# LA				
	2 & 3	1/2# CuS, 2# L, 3# LA				
	4	2# CuS, 4# L, 3# LA	32.8	3.7	3.7	145.2
	5,6 & 7	1/2# DDT	27.2	6.1	6.9	163.7

Block A - Single tree plots replicated five times. The standard of comparison for treatments in Block A is Plot 1, a 7-cover spray schedule of 3 pounds lead arsenate with fungicides per 100 gallons.

Group 1 - Tests of lead arsenate schedules (See Table 1.)

Increasing the lead arsenate dosage from 3 pounds (Plot 1) to 4 pounds (Plot 2) and to 6 pounds (Plot 10) in the 2nd, 3rd and 4th cover sprays gave a corresponding decrease in percentage of wormy fruit. Over a 50 percent reduction resulted from the use of 6 pounds instead of the standard 3-pound dosage.

No significant difference was noted in the effectiveness of two brands of summer oil emulsion sold extensively in this area when used in the second and third cover sprays (Plots 3 and 4), both increasing the control over Plot 2 by approximately 50 percent. Use of oil and lead without a fungicide in the second and third cover sprays increased its effectiveness but resulted in an increase in arsenical foliage injury due to the lack of a safener.

The two phenothiazine-lead arsenate combination treatments (Plots 8 and 9) produced more clean fruit than the standard but had more wormy fruit at harvest then any other treatment and were less effective than the oil-lead schedules.

Fruit finish was satisfactory in this group with the exception of the oil plots where a rough finish at harvest resulted.

Group 2 - Tests of lead arsenate-DDT schedules (See Table 2).

The addition of 1/2-pound of DDT to the standard in the first cover spray (Plot 11) was of no value this season. Some increase in efficiency was noted when additions were made in the second (Plot 12), third (Plot 13) and fourth (Plot 14) cover sprays. Addition of DDT in the second and fourth covers (Plot 16) was more effective than addition in the first and third (Plot 15) and both were more effective than the addition in one spray only. The greatest increase in efficiency resulted when DDT was added in all four first brood covers (Plot 17).

The addition of 1/4 pound of DDT to the standard schedule (Plot 18) effected about 12 percent reduction in wormy fruit and a marked reduction in stings but the addition of 1/2 pound of DDT to the 1 1/2 pound lead arsenate schedule (Plot 19) effected greater reductions as compared to the standard treatment, decreasing the number of wormy fruits by about 1/3 and the number of stings by about 2/3.

Use of DDT in second brood sprays following the standard in the first brood gave better control than the standard throughout. In Plot 20 where DDT was used alone in second brood sprays the control does not appear significantly better, but it will be noted in the table that first brood infestation in this plot was higher than in Plots 1, 6 and 7 used for comparison. While Plot 7, using DDT-summer oil in the three second brood sprays, gave increased control the preharvest fruit drop was almost double the average for the other plots in this group.

Table 3. Block B - Group 3 - DDT Concentrations

Plot No.	Cover Sprays	Materials per 100 Gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits: Worms	Per 100 Fruits: Stings
21	1 thru 7	1/4# DDT (1# of 25% DDT material K)	82.7 78.6	3.1 3.2	3.2 3.6	23.1 15.9
22	1 thru 7	1/2# DDT (2# of 25% DDT material K)	95.0 90.5	0.6 0.8	0.6 0.8	4.6 9.8
23	1 thru 7	3/4# DDT (3# of 25% DDT material K)	97.1 95.1	none 0.2	none 0.2	3.1 5.1
24	1 thru 7	1# DDT (4# of 25% DDT material K)	98.6 96.4	0.1 0.2	0.1 0.3	1.3 3.6
25	1 thru 7	2# DDT (8# of 25% DDT material K)	99.7 97.2	none 0.2	none 0.2	0.3 2.7

Table 4. Block B - Group 4 - Commercial DDT Formulations

Plot No.	Cover Sprays	Materials per 100 Gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits: Worms	Per 100 Fruits: Stings
26	1 thru 7	1/2# DDT (1 1/4# 40% DDT material A)	87.6 84.0	1.0 1.2	1.0 1.3	12.8 18.1
27	1 thru 7	1/2# DDT (2# 25% DDT material B)	73.4 58.6	7.5 17.9	8.5 25.5	27.3 42.7
28	1 thru 7	1/2# DDT (1# 50% DDT material C)	83.3 76.0	1.8 5.7	1.8 6.8	17.6 25.9
29	1 thru 7	1/2# DDT (2# 25% DDT material D)	86.5 76.0	1.6 5.0	1.7 6.6	13.1 25.7
30	1 thru 7	1/2# DDT (2# 25% DDT material E)	69.3 51.6	6.5 13.4	7.0 15.8	33.5 67.2
40	1 thru 7	1/2# DDT (2# 25% DDT material F)	76.7 85.2	0.8 1.9	0.8 1.9	13.7 15.5
50	1 thru 7	1/2# DDT (1 1/4# 40% DDT material G)	95.4 83.6	0.2 2.4	0.4 2.3	5.1 17.4
38	1 thru 7	1/2# DDT (3# 17% DDT material H)	90.5 89.3	0.3 0.6	0.3 0.6	10.3 11.7

Table 4. (Continued)

Plot No.	Cover Sprays	Materials per 100 Gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits: Worms	Per 100 Fruits: Stings
36	1 thru 7	1/2# DDT (3# 17% DDT-7% nicotine material I-BL 155)	85.6 70.7	1.1 11.8	1.1 15.4	16.1 27.4
37	1 thru 7	1/2# DDT (3# 17% DDT-7% nicotine material J-dry conc.)	96.2 88.1	none 1.9	none 2.2	4.1 12.0

Table 5. Block B - Group 5 - Special DDT Formulations

Plot No.	Cover Sprays	Materials per 100 Gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits: Worms	Per 100 Fruits: Stings
31	1 thru 7	1/2# DDT (2 1/2# 20% DDT impregnation of "Loomkill" talc)	82.4 64.3	7.7 16.7	9.3 24.0	12.5 31.2
32	1 thru 7	1/2# DDT (1# 50% DDT processed on Fuller's earth)	78.4 64.2	5.3 11.4	5.8 14.1	21.7 41.3
33	1 thru 7	1/2# DDT (1# 50% DDT micronized with pyrophyllite)	96.1 86.5	0.3 1.7	0.3 1.9	4.1 13.8
39	1 thru 7	1/2# DDT (2 1/2# 20% DDT impregnated on Miss. bentonite)	92.2 89.9	0.5 0.9	0.5 0.9	7.8 11.0
34	1 thru 7	1/2# DDT-1 1/2# LA (2# 25% DDT impregnated on lead arsenate)	92.3 77.0	0.4 3.6	0.4 4.5	8.0 26.6
35	1 thru 7	1/2# DDT-1 1/2# LA (2# 25% DDT processed with lead arsenate)	88.0 70.1	0.5 6.1	0.5 9.1	13.8 38.7

Table 6. Block B - Group 6 - Combinations with DDT

Plot No.	Cover Sprays	Materials per 100 Gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits: Worms	Per 100 Fruits: Stings
42	1 thru 4	1/2# DDT (2# 25%), 2# phenothiazine	98.8	0.3	0.3	1.0
	5 thru 7	1/2# DDT (2# 25%)	94.2	1.3	1.3	4.8
45	1 thru 7	1/2# DDT (2# 25%), 1/4# Miss. Bent. 1 qt. "Orthol-K" oil	96.9 95.4	0.4 0.6	0.4 0.6	2.9 4.4
48	1 thru 3	1/2# DDT (2# 25% DDT), 1 pt. BL-40, 5# Miss. bent., 1 qt. "Orthol-K" oil				
	4	1/2# DDT (2# 25% DDT), 1 pt. BL-40, 8# Miss. Bent., 3 qt. "Orthol-K" oil				
	5 thru 7	1/2# DDT (2# 25% DDT), 2/3 pt. BL-40, 5# Miss.bent., 3 qt. Orthol-K oil	99.7 98.5	none 0.3	none 0.3	0.3 1.3

Table 7. Block B - Group 7 - DDT Combinations with Red Mite Control Materials

Plot No.	Cover Sprays	Material per 100 Gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits	
					Worms	Stings
46	1 thru 7	1/2# DDT (2# 25% DDT)	93.9	0.4	0.4	6.2
	4	6 qt. "Orthol-K" added	90.8	1.1	1.1	9.2
47	1 thru 7	1/2# DDT (2# 25% DDT)	93.9	0.9	0.9	5.0
	3 & 4	6 qt. "Orthol-K" added	94.3	0.4	0.4	5.8
41	1	1/2# DDT (2# 25% DDT)				
	2 thru 7	1/2# DDT (2# 25% DDT), 1# Xanthone	99.6	none	none	0.4
		2 oz. Genefilm B, 1 pt. kerosene	95.4	1.2	1.2	3.9
49	1	1/2# DDT (2# 25% DDT)				
	2 thru 7	3/8# DDT-3/4# Xanthone (1 1/2# DDT-Xanthone mix), 2 oz. Genefilm B,	97.0	none	none	3.2
		3 pts. kerosene	91.6	0.4	0.4	9.3
43	1	1/2# DDT(2# 25% DDT)				
	2 thru 7	1/2# DDT (2# 25% DDT), 1 1/4# DN-111 (Formula C-454)	94.3	0.2	0.2	5.9
			91.3	1.2	1.3	8.5
44	1	1/2# DDT (2# 25% DDT)				
	2 thru 7	1/2# DDT (2# 25% DDT) 1/2# DN dry mix (Formula D-307)	98.3	none	none	1.7
			95.6	0.5	0.5	4.3

Table 8. Block B - Group 8 - Miscellaneous Formulations - Unreplicated Plots

Plot No.	Cover Sprays	Materials per 100 Gallons	% Clean Fruits	% Wormy Fruits	Per 100 Fruits	
					Worms	Stings
80	1 thru 7	1/2# DDT dissolved in 1 1/2 pt. xylene & emulsified with B-1956	97.5 87.8	none 0.3	none 0.3	2.5 14.4
89	1 thru 7	1/2# DDT dissolved in 1 1/2 pt. Velsicol & emul. with B-1956	98.0 94.8	none 0.9	none 0.9	2.0 5.5
81	1 thru 7	1/2# DDT dissolved in 1 1/2 pt. benzene & emulsified with B-1956	72.0 70.8	15.0 9.5	17.0 11.4	23.5 27.2
88	1 thru 7	1/4# DDT dissolved in 3/4 pt. benzene & emulsified with B-1956	50.9 22.2	21.5 37.2	28.7 55.3	66.6 115.4
91	1 thru 7	1 1/2# LA treated with 3/4 pt. benzene & dried	69.5 40.1	2.5 16.0	2.5 19.8	45.9 92.9
90	1 thru 7	1/4# DDT impregnated on 1 1/2# LA with benzene	85.4 68.8	1.2 5.3	1.6 6.5	15.9 34.9
83	1 thru 7	1/2# DDT impregnated on 1 1/2# LA with benzene	94.4 77.6	0.7 5.3	0.7 5.6	4.9 20.8
82	1 thru 7	1/2# DDT impregnated on 3# LA with benzene	93.0 83.1	0.5 1.4	0.5 1.5	7.6 19.4
87	1 thru 7	1/2# DDT impregnated on 1 1/2# LA with xylene	96.4 84.4	none 1.3	none 1.3	3.6 16.7
92	1 thru 7	1/2# DDT impregnated on 1 1/2# LA with acetone	97.5 54.9	none 5.4	none 8.2	2.5 61.6
84	1 thru 7	1/2# DDT impregnated on 2# Miss. bentonite with benzene	94.1 78.6	1.5 7.1	1.5 7.6	4.4 17.6
93	1 thru 7	1/2# DDT impregnated on 2# Miss. bentonite with acetone	84.0 70.3	2.1 2.8	2.6 3.2	17.4 38.7
94	1 thru 7	1/2# DDT impregnated on 4# Miss. bentonite with 1 1/2 pt. acetone	98.0 82.8	none 0.6	none 1.0	2.0 19.7
85	1 thru 7	1/2# DDT impregnated on mixture of 2# bentonite and 1 1/4# DN-111 with 1 1/2 pt. benzene	92.4 82.9	1.5 4.4	1.5 5.1	7.6 13.5
86	1 thru 7	1/2# DDT impregnated on mixture of 2# bentonite and 1# xanthone with 1 1/2 pt. of benzene	95.9 90.3	0.5 1.9	0.5 2.2	3.5 9.2

Block B - Single tree plots replicated five times (except in Group 8 where no replications were used).

Where DDT is indicated in the combination schedules the commercial formulation K was used.

The standard for comparison of treatments in Block B is Plot 22, that is, 1/2 pound actual DDT per 100 gallons obtained by use of 2 pounds of the 25 percent DDT commercial formulation K. In 1944 and 1945, this commercial formulation was as effective as the 1:1 DDT-pyrophyllite micronized formulation.

Practically all DDT formulations, when used in 7 cover sprays, left an objectional visible residue at harvest which was not removed by brushing. Chemical analyses have not yet been received of the DDT residues at harvest, but comparison with the 1944 schedules and residues and those received on this season's work by other workers with similar schedules leads us to believe that in most cases the residues will be near the tolerance of 7 milligrams per kilogram of fruit.

Group 3 - Tests of DDT concentrations (See Table 3).

Five concentrations of DDT, 1/4, 1/2, 3/4, 1 and 2 pounds per 100 gallons, were tested. All concentrations were highly effective although the 1/4-pound one was somewhat inferior to the others. The 1/2-pound and heavier concentrations all kept the percent of wormy fruits and total worms per 100 apples to less than one and held stings to a very low level.

Group 4 - Tests of Commercial DDT formulations (See Table 4).

Eleven formulations prepared by commercial concerns were tested in Block B. Eight of these were sold commercially in this area in 1945 and the other three given limited field tests by growers in cooperation with the manufacturer. It is of interest to note the variation in control effected by these materials when applied at the same concentration, in the same manner, by the same operators using the same equipment and applied within a period of approximately 2 hours at each coverage. Three of these materials definitely proved inferior to the others and 6 significantly better than the 2 in between.

Group 5 - Tests of DDT formulations (See Table 5) of six special DDT formulations prepared by various methods, an impregnation of "Loomkill" talc with a DDT-benzene solution (Plot 31) was least effective. This material was difficult to wet, requiring pasting before introduction into the tank.

The micronized 1:1 DDT-pyrophyllite material (Plot 33) was even more difficult to wet than the impregnated talc formulation but gave excellent control of the codling moth.

The impregnation of Mississippi bentonite with a benzene solution of DDT to produce a 20-percent DDT formulation (Plot 39) was easily handled, mixed readily in the tank and gave excellent control.

Neither of the two 1:3 DDT-lead arsenate combinations were as effective as the standard (Plot 22) although the impregnation of DDT on lead arsenate (Plot 34) appears to be more effective than when the two materials are merely ground together (Plot 35). Severe foliage injury resulted from the use of these two materials without a safener for the lead arsenate.

Group 6 - Tests of combinations with DDT (See Table 6).

Each of three combinations of DDT with other insecticides gave a highly satisfactory degree of control but not enough more than the standard treatment of DDT alone to justify the expense of the additional materials. Also, the DDT-phenothiazine combination (Plot 42) was caustic to those handling it and the DDT-bentonite-oil combination (Plot 45) and the DDT-nicotine-bentonite tank-mix combination (Plot 48) resulted in heavy visible residue at harvest and caused heavy preharvest fruit drop.

Group 7 - Tests of DDT combinations for Red Mite control (See Table 7).

Six plots were set up for testing the effect of red mite control combinations on the efficiency of DDT. The addition of 6 quarts of summer oil emulsion in the fourth cover spray (Plot 46) and in the third and fourth cover sprays (Plot 47) did not reduce the efficiency of DDT. However, fruit from both plots showed a roughness of finish at harvest and heavy preharvest fruit drop occurred on Plot 47.

Combination of DDT with Xanthone (Plot 41) and the DDT-Xanthone prepared mixture (Plot 49) gave effective codling moth control but the kerosene tended to roughen the fruit finish and both plots had objectionable visible residue. Preharvest drop in these two plots was less than average.

Addition of two DN (dinitro-o-cyclohexylphenol) compounds to DDT schedules (Plots 43 and 44) did not reduce codling moth control nor did either produce any unfavorable conditions on fruit or foliage. Preharvest drop in these two plots was about average.

Group 8 - Tests of miscellaneous formulations (See Table 8).

This group consists of unreplicated single tree plots to which 7 cover sprays of various experimental formulations prepared at this station were applied. Their comparative value is indicated in Table 8.

Large-Scale Orchard Tests with DDT

Four large-scale orchard tests of DDT were observed during the 1945 season and as much data taken as time permitted. Information on the test blocks and the results observed may be summarized as follows:

(1) Border Orchard at Kearneysville, W. Va.: A block of Yorks 10 rows wide and 47 trees long was given 6 applications of a combination lead arsenate-DDT spray consisting of 3 pounds lead arsenate and 1/2 pound DDT (2 pounds of a 25 percent DDT wettable powder) per 100 gallons. This block was bounded on the southeast by Black Twigs which had no fruit and on the northwest by a block of Stayman with a light scattered crop. A small block of Yorks northwest of the Stayman one was given 6 applications of lead arsenate with Bordeaux mixture. A very heavy infestation was carried over from 1944. Examination of 4000 fruits (20 samples of 200 fruits each) taken at random at harvest over the DDT-lead arsenate block showed 90 percent clean fruit and 2.2 worms and 9.9 stings per 100 apples as compared to only 8 percent clean fruit and 53.1 worms and 416.5 stings per 100 apples in the lead arsenate block where 800 fruits (4 samples of 200 fruits each) were examined.

(2) G. E. R. Orchard, four miles northwest of Martinsburg, W. Va.: A block of approximately 25 acres of Yorks was sprayed with lead arsenate-DDT-Bordeaux using 1/2 pound DDT (2 pounds of a 25 percent DDT wettable powder) and 3 pounds of lead arsenate per 100 gallons. Only 4 cover sprays were applied and all were directed against the first brood. The infestation carried over from 1944 in this orchard was fairly heavy, though not as heavy as in the Border Orchard. Harvest counts of 4000 fruits (20 samples of 200 fruits each) taken at random over this block showed 86 percent clean fruit and 6.5 worms and 12.7 stings per 100 fruits. Only two 100 fruit samples were available from a lead arsenate sprayed block and these showed only 18 percent clean fruit and 75.5 worms and 137.5 stings per 100 fruits. Only four lead arsenate applications had been made.

(3) Hockensmith Orchard at Shenandoah Junction, W. Va.: The infestation in this orchard was very heavy and comparable to that in the Border Orchard. The DDT block contained trees of the Delicious and Winesap varieties and the experimental treatment consisted of 1/2 pound DDT (2 pounds of a 25 percent water dispersible powder) and 3 pounds lead arsenate per 100 gallons of Bordeaux mixture. Seven applications were made, 5 first brood and 2 second brood with DDT being used in all but the first. Results in this block were compared with those in a block of Yorks given 7 applications of 3 pounds lead arsenate per 100 gallons of Bordeaux mixture plus, in the last 6 covers, 3 quarts summer oil and, in the last cover, 1/2 pound DDT. Examination of 2000 apples (10 samples of 200 each) at harvest showed 68 percent clean fruit and 1.1 worms and 46.3 stings per 100 apples in the DDT-lead arsenate block as compared to 4 percent clean fruit and 35.5 worms and 484.6 stings per 100 apples in the lead arsenate-oil block where 1000 apples (5 samples of 200 each) were examined.

(4) Chew Orchard near Leetown, W. Va.: This orchard had a heavy carry-over of infestation from 1944. DDT was used in only one cover spray in this orchard, the third, and was of little value. A count of 2000 fruits (10 samples of 200 fruits each) showed only 19 percent clean fruit with 38.9 worms and 272.8 stings per 100 apples. There was no check for comparison in this orchard.

European Red Mite

Tests of materials and schedules for control of the European red mite and other mites were carried throughout the season but the infestation in the plots set up for these tests was too light to provide an adequate test of either materials or schedules. Likewise, no serious mite infestation developed in DDT plots run by growers. However, compatability of some of the mite control materials with DDT was established in the schedules in Group 7 of the codling moth control tests.

Control of Codling Moth by Chemical Removal of Crop

The experiment started with the defruiting of the trees in the Hensell orchard in 1942 in an attempt to eliminate the codling moth by this means was concluded with the 1945 season. In the intervening period, no sprays were applied for codling moth control and, each year, sufficient fruit was examined to indicate the rate at which the codling moth population built up following the defruiting. Results are tabulated

below and indicate that defruiting as a method of codling moth control is impractical since only a single relatively clean crop of fruit could be anticipated without resort to spraying following such a program.

Summary of Population Build-Up in Hensell Orchard on Count Trees

1941--45

Year	Total Fruit	First Brood			Season		
		Percent Fruit Injured	Per 100 Fruits		Percent Fruit Injured	Per 100 Fruits	
			Worms	Stings		Worms	Stings
1941	106908	14.1	8	9	48.5	55	19
1942	None						
1943	36557	2.0	0	2	12.1	9	9
1944	20657	18.9	11	13	71.2	127	24
1945	40362	54.3	71	24	79.0	162	39

VINCENNES, INDIANA

L. F. Steiner, In Charge 1/

Seasonal Conditions and Codling Moth Development

Rainfall was excessive during the six-month period from April 1 to September 30, the total at Vincennes being 35.4 inches or 53 percent above normal. Mean daily temperatures averaged 3.4° below normal between May 1 and August 31. Frosts as late as May 11 and unfavorable weather during bloom reduced the crop to about 30 percent of full. Apple scab caused serious damage.

Spring-brood moth emergence began on April 12, 13 days earlier than any previous record but a return to cool weather lengthened the incubation period of the first eggs to 26 days. The largest bait trap catches of the season occurred May 5-6 (2061 moths in 106 traps) but, because continued unfavorable weather interfered with moth activity, the heaviest first-brood hatch was delayed and did not occur until between June 15 and 20. By that time few spring-brood moths (an estimated 3 percent) were present.

Second-brood hatch reached a peak early in August and the third-brood hatch was the lightest observed in more than 10 years.

1/ The chemical analyses and particle size determinations reported herein were made by J. E. Fahey, Division of Insecticide Investigations. Mr. Fahey also processed most of the DDT formulations used in these experiments.

Most growers who sprayed moderately had very clean crops. The following data illustrate the effect of differences in the seasonal conditions on control for comparable treatments applied to the same blocks of trees each season. No supplemental control measures were used between the two seasons.

Treatment	Percent Wormy Apples	
	1944 (10 sprays)	1945 (7 sprays)
Lead arsenate, Bordeaux, oil	68	14
Nicotine bentonite, oil	28	9
DDT	13	2

Laboratory Experiments with Insecticides

Tests conducted under controlled conditions where codling moths (usually 100 per test) were allowed to rest for varying periods of time on residues from DDT solutions indicated that the age of the deposit, the type of solvent used and the length of exposure each greatly affected the results.

Moths require about an hour after emergence before they can fly. Deposits from solutions of DDT in Velsicol AR60 were much more toxic up to four days of age than those of DDT in benzene or kerosene or of a water suspension. DDT deposited from a benzene solution had almost no toxicity during the first three days. Thereafter its toxicity increased and when from six to fifteen days old it was more toxic than DDT deposited from the Velsicol solution. The results did not indicate that the application of concentrated sprays to tree trunks or ground debris to kill moths that emerge later would be practicable.

In larvicidal efficiency tests, atomized solutions of DDT in xylene in Velsicol AR-50 special, and in Velsicol + soybean oil applied to fruit with a power duster at a distance of 20 feet gave very promising results. In subsequent tests on Grimes foliage in April solutions containing Velsicol caused severe foliage injury.

DDT Formulations

Most of the insecticide work in 1945 involved studies of DDT. With the exception of DDT-xanthone, DDT-Fuller's earth, micronized DDT-Pyrax and 5 factory-processed formulations all DDT preparations were formulated at the laboratory. A Mikropulverizer was used to prepare all dry powders and some of the pastes. A pebble mill was employed in preparing pastes used early in the season.

Particle size determinations by air permeation apparatus revealed that use of the Mikropulverizer in hot weather without facilities for cooling yielded formulations of larger particle size than had been obtained early in the season. For example, DDT-kaolin (1:1) processed April 28 had a mean particle diameter of 4.4 microns (the kaolin alone measuring 1.4) while that processed on August 4 averaged 6.0 microns. This introduced an unexpected variable in those tests where DDT-kaolin prepared in August was compared with formulations prepared in April or May. As in 1944, water pastes prepared from 1945 technical grade DDT could not be ground as fine in the equipment available as could those made from technical DDT supplied in 1943. The mean particle diameter of technical DDT pastes ranged from 12 to 19 microns for different batches. Aerosol grade DDT pastes processed similarly were reduced to from 6 to 7.1 microns from the same initial particle size.

Photomicrographs of all formulations tested showed that a wide range in particle size of the DDT existed in some of the factory processed materials while others were very uniform. The most uniform mixture with respect to particle size of both DDT and diluent was the micronized DDT-Pyrax.

Unusual uniformity of particle size was also present in the 10 and 2.5 micron lots of the aerosol grade DDT prepared by Mr. Fahey.

Laboratory-Field Experiments

The usual method of conducting these experiments was followed (Bureau Circular E-448, September, 1939). Stratified 60-apple samples were taken from each plot shortly before and after the cover sprays and before harvest for larvacide tests and additional ones were taken by the chemists for analyses. Ten newly hatched larvae were applied to each apple under controlled laboratory conditions. The larvae came from mixed local strains having a relatively strong ability to enter fruit sprayed with lead arsenate. Some 400,000 larvae were utilized in these tests.

A block of 50 mature Golden Delicious trees was used for two series of tests and another of mature Rome Beauty for a third series. Sprays were thoroughly applied at 600 pounds pressure..

The Golden Delicious were sprayed uniformly by the grower with lead arsenate, sulfur and lime through the first cover spray. Eight additional sprays were applied by us. The Rome Beauty were given a uniform calyx application of lead arsenate, sulfur and lime in two 1-side applications on April 17 and 19 followed by a sulfur dust on April 23 and 7 cover sprays of the test treatments.

The cover sprays were applied on the following dates:

Spray Number	Golden Delicious		Rome Beauty
	Series 1	Series 2	
1	May 8	May 8	May 1-5
2	May 17-18	May 17-18	May 11-12, 14
3	May 29-31	May 30-31	May 23-24
4	June 11-12	June 12	June 2,4
5	June 20-21	June 20	June 15-16
6	July 10-11	July 10	July 4-5
7	July 31-Aug. 1	July 31	July 27-28
8	Aug. 13-14	Aug. 14	--
9	Aug. 30	Aug. 30	--

Only a few of the treatments applied to Golden Delicious were continued throughout the season. New comparisons were set up as earlier tests were discontinued.

Average larvicidal efficiencies and deposits at the beginning and end of specified weathering periods are given herein rather than the detailed paired efficiency and deposit data.

The abbreviations used to indicate spray materials referred to in the tables in this report are listed below:

Bdx. 3/4 (3/4:1-1/2:100 bordeaux)

Bdx. 1 (1:2:100 bordeaux)

Bdx. 4 (4:8:100 bordeaux)

B-1956 (Rohm & Haas Triton B-1956)

Bl. 155-DDT (Blackleaf 155-DDT 17% DDT, 7% Nic.)

DDT-17 (Tob. By P. & Chem. Corp. 17% DDT powder)

DDT-A (DDT Aerosol grade)

DDT-B (DDT-Bancroft clay (1:1, milled)1/

DDT-C (DDT technical, conditioned)

DDT-D4 (DDT 5%, Pyrax 10%, D4 (dinitro) dust 85%)

DDT-FE (DDT-Fuller's earth 1:1)

T-K (DDT-kaolin (Cherokee clay) 1:1, milled)

B.
5/18-33 (DDT-kaolin (Cherokee clay)
6 spr 1:2, milled)
13.87
inches DDT-lead arsenate, 6 oz.:2 lb.
rainf milled)

-P (DDT-Pyrax 1:1, micronized)

DDT-Paste (DDT-water)

DDT-PC (20% DDT "impregnated" in Panther Creek Miss. bent. by Tob. By P. & Chem. Corp.)

DDT-R-N (DDT 5%, Rotenone 0.6%, Nic. 1.2% in tobacco dust carrier)

DDT-WSF (DDT 5%, walnut shell flour 95%, milled)

DDT-Wyo.B. (DDT milled with Wyoming bentonite 6 oz. to 2.5 lb.)

DDT-X (DDT milled with Filtrol X-415-Mississippi bentonite, 1:4)

Deenate (DuPont's 25% wettable DDT powder)

Fermate (ferric dimethyl dithiocarbamate)

G-AK-40 (Geigy's 40% wettable DDT powder)

HMF (hydroxy methyl flavan, 25%)

KWK (Wyoming bentonite, pellet type)

LA (acid lead arsenate, standard)

Li. (hydrated spray lime)

NS (nicotine sulfate, 40%)

OK oil (Orthol K emulsive type 98% summer oil)

S (wettable sulfur)

SF (soybean flour)

S. oil (crude soybean oil)

X-415 (Filtrol Corp. Miss. Bentonite. Same as X110 used in previous years except abrasive material reduced.)

ZNF (zinc nicotinyl fluosilicate, 25%)

1/ "Milled", as used herein refers to processing in dry form in a Mikropulverizer. Most materials were put through 4 times.

Golden Delicious

Efficiency and deposit data obtained from the Golden Delicious variety are given in table 1. Because of differences in spray or sampling dates the two series of tests are not directly comparable. Unless otherwise indicated all formulas were made comparable on an actual DDT basis, 3/4 lb. per 100 gal. being used in the sprays prior to July 1, and 1/2 lb. thereafter.

Table 1. Average Percent Larvicidal Efficiencies and Spray Deposits. Vincennes, Ind. 1945

Series 1. Golden Delicious

Period	Plot	Materials per 100 gals.	0 to 2 days after spraying Effic. %	0 to 2 days after spraying DDT mmg/cm²	6 to 20 days after spraying Effic. %	6 to 20 days after spraying DDT mmg/cm²
A. 5/18-9/11, 8 sprays, 18.83 inches rainfall	3	Deenate + 3 lbs. S. in 2 sprays	99.8	11.2	83.3	7.5
	4	No. 3 + 3 lbs. S. in 1 spray, 1 lb. Fermate in 3, 1 qt. OK oil in 5 (2 with Fermate)	99.8	16.6	86.2	11.8
	5	DDT-K33 (Standard of comparison)	99.6	12.7	82.8	8.0
	16	No. 5 + 3 lbs. S. in 1 spray, 1 qt. OK oil + 4 ozs. SF + 4 ozs. Li. in 6 sprays	98.7	16.5	82.8	13.1
	8	DDT-P	99.6	10.4	79.5	7.2
	9	No. 8 + 1 qt. OK oil and 4 ozs. KWK	99.9	26.4	93.4	20.4
	10	Atomized solution. 1 lb. DDT per gal. in 1:3 xylene-kerosene 280 ml. per tree application	77.6	8.7	53.5	5.5
	12	Dust. DDT-R-N. 3.3 lb. per tree application	66.5	4.5	27.6	3.4
B. 5/18-8/10, 6 sprays, 13.87 inches rainfall	5	DDT-K33 (As No. 5 above)	99.7	12.0	78.8	6.7
	10	As No. 10 above	79.4	8.5	55.1	5.2
	11	Atomized solution. 1 lb. DDT per gal. in 1:1 xylene-S. oil (3 sprays). Gulf 301 mineral oil substituted for S. oil in 3 sprays. 300 ml. per tree appl.	69.8	7.7	37.1	6.0
	12	As No. 12 above	68.3	4.5	28.1	3.4
	13	Dust. DDT-D4, 4 applications DDT-WSF thereafter. 3.1 lb. per tree application	68.7	3.3	25.6	2.0
C. 5/18-7/6, 4 sprays, 10.79 inches rainfall	5	As No. 5 above	99.3	9.3	74.5	5.4
	7	No. 5 at double strength	99.7	17.4	86.3	10.2
	14	No. 5 + 2 lbs. Uramon (urea)	99.0	12.8	77.1	6.8

Table 1 (continued)

Series 1. Golden Delicious (con.)

Period	Plot	Materials per 100 gals.	0 to 2 days after spraying Effic. %	0 to 2 days after spraying DDT mmg/cm²	6 to 20 days after spraying Effic. %	6 to 20 days after spraying DDT mmg/cm²
D. 5/18-6/18, 3 sprays, 8.48 inches rainfall	5	As No. 5 above	99.4	7.8	71.4	5.1
	6	No. 5 + 1-1/4 lb.DN-111(dinitro)	98.4	8.5	70.6	5.5
	15	No. 5 + 1 pt. Loro (lauryl rhodinate)	96.2	10.8	60.5	7.0
E. 6/21-8/27, 4 sprays, 10.04 inches rainfall	5	As No. 5 above	99.6	15.6	87.7	8.9
	6B	No. 5 + Bdx. 4	99.8	12.0	88.6	8.4
	6A	No. 6 B + 1 qt. OK oil	100.0	18.3	91.4	13.2
F. 7/11-9/11, 4 sprays, 8.04 inches rainfall	5	As No. 5 above	99.8	16.1	91.2	10.6
	5C	No. 5 + 1 qt. OK oil and 1/2 to 1 lb. "DDT Depositor"	100.0	20.9	96.2	16.7
	16	No. 5 + 1 qt. OK oil, 4 ozs. SF, 4 ozs. Li.	99.7	21.8	93.6	17.9

Series 2. Golden Delicious

Period	Plot	Materials per 100 gals.	0 to 5 days after spraying Effic. %	0 to 5 days after spraying DDT or Nic. mmgs/cm²	6 to 21 days after spraying Effic. %	6 to 21 days after spraying DDT or Nic. mmgs/cm²
A. 5/22-9/12, 8 sprays 18.77 inches rainfall	1	NS, X-415, OK oil (1 pt., 8 lb., 2 qt. in 4 sprays, 3/4 pt., 6 lb., 2 qt. thereafter)	90.7	4.6	79.8	2.3
	5B	DDT-K33 (As No. 5 in Series 1)	98.4	12.3	78.4	7.7
	18	DDT-xylene. 1:2-1/2 in 4 sprays, 1:3 thereafter. 0.5 oz.B-1956 in all	98.5	18.1	85.1	13.3
	20	DDTA, 2.5 microns SMPD ground in water with 0.25 ozs. B-1956	99.8	13.6	93.0	9.0

Table 1. (continued)

Series 2 (con.)

Period	Plot	Materials per 100 gals.	0 to 5 days after spraying		6 to 21 days after spraying	
			Effic. %	DDT or Nic. mmgs/cm^2	Effic. %	DDT or Nic. mmgs/cm^2
B. 5/22-7/9, 4 sprays, 10.73 inches rainfall	5B	As No. 5B above	97.4	8.8	69.1	5.4
	17	DDT-benzene 1:2.5 + 0.5 oz. B-1956	91.3	7.8	45.0	5.2
	18	DDT-xylene 1:2.5 + 0.5 oz. B-1956	97.0	13.7	72.8	9.5
	19	DDT-C + 0.25 oz. B-1956	95.7	8.9	66.8	4.2
	20	DDTA (2.5 microns SMPD) + 0.25 oz. B-1956	99.6	10.2	89.8	6.5
	21	DDTA (10 microns SMPD) + 0.25 oz. B-1956)	93.4	8.9	54.6	4.8
	22	DDTA (26 microns SMPD) + 0.25 oz. B-1956)	60.9	6.2	21.1	2.6
C. 7/10-9/12, 4 sprays, 8.04 inches rainfall	1	As No. 1 above	96.6	4.5	92.2	2.9
	1A	ZNF 3 lb. + 2 qt. OK oil	90.8	3.2	79.0	2.1
	7B	As No. 1. First 4 sprays same as 7 in Series 1	97.9	3.0	93.6	2.1
	5B	As No. 5B above	99.5	15.8	87.8	10.0
	14A	DDTA ground with water. No wetting agent	99.7	15.1	92.8	10.8
	14B	DDTA-cherokee clay (kaolin) 1:2	99.8	16.2	94.6	11.5
	19A	DDT-C-cherokee clay, 1:2	99.8	14.3	91.4	9.9
	17	DDT-benzene 1:3 + 1 qt. OK oil and 4 ozs. KWK	97.1	22.6	84.9	18.5
	18	DDT-xylene 1:3 + 0.5 oz. B-1956	100.0	22.6	97.4	17.1

Table 1. (continued)

Series 2. Golden Delicious (con.)

Period	Plot Materials per 100 gal.	0 to 5 days after spraying		6 to 21 days after spraying	
		Effic. %	DDT or Nic. mmgs/cm2	Effic. %	DDT or Nic. mmgs/cm2
D. 6/12-7/9, 2 sprays, 6.31 inches rainfall	1 As No. 1 above	94.8	4.7	88.8	1.9
	2 No. 1 + 1 lb. Cu8 hydroxy quinoline	96.0	4.8	86.4	2.0
	2B No. 1 + 189 ml. Puratized N5E	94.7	3.8	80.0	1.8
	5B As No. 5 above	99.5	13.2	87.4	7.0
	5A No. 5B + 189 ml. Puratized N5E	99.6	14.5	88.4	6.5
	5C No. 5B + 1 lb. Cu8 hydroxy quinoline	98.6	13.9	87.0	8.0
	5D No. 5B + 3 lb. S.	98.9	12.8	81.3	7.6
	5E No. 5B + 4 lb. Kolofog (bentonite-sulfur)	97.8	14.4	82.6	8.2
E. 8/2-9/12, 3 sprays, 5.46 inches rainfall	5B As No. 5 above	99.3	15.6	91.4	10.5
	5DE DDT-kaolin (SE Clay Co. Type 41) 1:2	98.2	13.1	86.0	11.4
	22A DDT-kaolin (Tamm's China L clay) 1:2	99.0	11.7	91.8	9.8
	21A No. 22A + 4 lb. HMF	98.6	13.4	93.8	10.4

Differences of more than 3 percent in the average larvicidal efficiencies given in Table 1 may be considered statistically significant.

In Series 1-A, Deenate and DDT-kaolin (1:2) were equally effective when used without oil and more effective after weathering than DDT-Pyrax. The latter, however, as in 1944, gave outstanding results when supplemented with 1 quart oil and 4 ounces Wyoming bentonite. The addition of oil increased the deposits of all three formulations. The solution (10) was atomized into the air blast of an orchard duster at 50 pounds pressure and at the rate of 4.5 gallons per hour through 3 nozzles mounted in a fish-tail shaped outlet attached to the blower pipe.

The atomized solution was less effective than the spray suspension and burned the foliage when applied in cool or humid weather. The DDT-rotenone-nicotine dust was least effective.

In Series 1-B the results of tests with a DDT-xylene-oil solution and another dust treatment are shown. The solution was even more injurious than the DDT-xylene-kerosene formula and less effective.

Urea was added to DDT-kaolin (Plot 14, 1-C) to observe the effect on efficiency of the DDT as well as the red mite population. It had no effect on either but the fruit on this plot stayed green a few days longer. DN-111 (Plot 6, 1-D) and Loro (Plot 15), were included for the same reason, the former having no effect on efficiency. Loro increased the deposit but greatly reduced the effectiveness.

A 4:8:100 bordeaux with and without oil, 6A and 6B (Series 1E) had no adverse effect on the DDT-kaolin formulation. The oil increased the DDT deposits and their effectiveness.

A commercial "DDT Depositor" (5C) prevented preferential wetting of DDT by the oil and gave slightly better results than slurry of 4 ounces lime and 4 ounces soybean flour (16).

In Series 2A, the standard nicotine bentonite proved less effective than DDT (5B) when the deposits were comparatively fresh but was equally effective after longer periods of weathering. Similar results were noted in 1944. A DDT-xylene emulsion (18) proved considerably superior to DDT-kaolin both in effectiveness and in amount of deposit but it was less effective than a water paste of the aerosol grade (20) ground to 2.5 microns surface mean particle diameter.

In Series 2B, a benzene emulsion (17) was much less effective than the xylene formula during the early part of the season. Later (Series 2C) when mineral oil and bentonite was added to the benzene emulsion (17) the results were more satisfactory but still not as good as obtained with a DDT-kaolin suspension or with the xylene emulsion. The conditioned technical DDT with a mean particle diameter of 7.7 microns was only slightly less effective than the DDT-kaolin.

Plots 20, 21, and 22 were arranged to evaluate the importance of particle size. The tests were made with the aerosol grade of DDT because it could be separated into close fractions while the technical grade could not. A minimum but equal quantity of wetting agent was used with each lot. This was necessary to hold the coarse material in suspension even with agitation but could have been omitted from the 2.5 micron preparation.

As evident from Series 2B (Plots 20, 21, 22) the 2.5-micron material was far more effective than the 10-micron lot and that in turn was much more effective than the aerosol grade in its original form. The cause of this increased effectiveness has not yet been determined.

Nicotine bentonite (Plot 1 in Series 2C) was significantly more effective than zinc nicotinyl fluosilicate (1A). The change from DDT to nicotine bentonite (Plot 7B) resulted in no loss of effectiveness during the period while nicotine deposits were being built up. The aerosol grade DDT ground with water (14A) to a mean particle diameter of 6 to 7 microns in the Mikropulverizer gave significantly higher efficiencies after weathering but no larger deposits than technical DDT ground with kaolin (5B).

Still higher efficiencies were obtained when the aerosol grade DDT was ground with kaolin (14B). They may have resulted from a greater reduction in particle size since the material used on plot 14B averaged 1.8 microns, only slightly more than the kaolin itself, while that used on plot 5B averaged 2.5.

It appears highly probable that differences in particle size of the DDT in various formulations may account for most of the differences in effectiveness when used without oil and that the optimum mean diameter of the DDT particles may be 2 microns or less. The aerosol grade of DDT is believed superior to the technical one for the production of low particle-size water dispersible powders.

From the Series 2D tests it seems evident that the new fungicide Puratized N5E may adversely affect the efficiency of nicotine bentonite but not DDT. It is also evident from these tests that the mild sulfurs reduce effectiveness after periods of weathering largely by reducing toxicity rather than resistance to weathering.

In Series 2E, type 41 kaolin with DDT proved less effective after weathering than Cherokee clay or China L clay. Of the three types the Cherokee clay mixture was more difficult to we. than the others and its particle size was the largest. Hydroxy methyl flavan had no adverse effect when used with DDT-kaolin.

In 1944 it was reported that heavy DDT deposits appeared toxic to mites since the mite and spider populations on a DDT-Pyrax-oil plot were negligible and appeared less than could be accounted for by the use of 1/4 percent summer oil. Evidence has been obtained as will be shown later, that the mixture is very toxic to and effective in controlling mites at the time of application. The numbers of European red mites, Paratetranychus pilosus, and common red spider, Tetranychus bimaculatus present on several of the plots after the last spray are given in Table 2, along with the DDT residues at harvest.

Table 2. Number European Red Mites and Common Red Spiders per Leaf on September 7 and the DDT Residues in Parts per Million on September 11 and 12, Series 1 and 2 plots. Vincennes 1945.

Series 1			Series 2		
Plot	DDT PPM	Mites and Spiders per Leaf	Plot	DDT PPM	Mites and Spiders per Leaf
3	11.8	18	5B	11.8	5
4	23.8	2	5DE	14.2	6
5	14.0	13	7B	8.2	4
5C	25.7	4	14A	12.2	32
8	10.5	1.3	14B	18.0	10
9	36.7	0.4	17	27.1	0.4
10	8.1	6	18	22.1	6
12	3.5	1	19A	14.1	27
13	3.6	1	20	12.4	6
16	21.6	0.6	21A	13.7	4
			22A	11.9	40

Since these are unreplicated plots differences in the mite populations are not all the result of the spray programs. In general the plots which received oil, Nos. 4, 5C, 9, 16 and 17, had the heaviest DDT residues and the lowest mite populations. Outstanding exceptions were the dust plots, Nos. 12 and 13, and No. 21A, each of which received supplemental materials effective against mites.

Experiments with Benzene Hexachloride

A small quantity of benzene hexachloride (British 666) containing 35 percent of the gamma isomer was received in time for use in the final cover spray. The material was ground with an equal quantity of kaolin (Cherokee clay) for use in a spray suspension and mixed with enough kaolin to make a dust containing 5 percent of the gamma isomer. The spray was diluted to 1/2 pound of the gamma isomer per 100 gallons and applied to a tree in Plot 5B (sprayed with DDT-kaolin earlier). The dust was applied to one tree in a plot previously dusted with DDT-walnut shell flour.

Single applications made August 30 gave the following results.

Residual efficiency on Aug. 27 from earlier DDT applications.	Spray applied Aug. 30	Percent larvicidal efficiency			Mites and Spiders per 100 Leaves 1/	
		Aug. 30	Sept. 11	Sept. 17	Aug. 30	Sept. 7
93.4	DDT	100.0	97.4	87.4	1,696	1,304
93.4	666	95.3	75.3	71.0	448	2,584
	Dusts					
28.8	DDT	70.5	23.6	--	--	--
33.3	666	67.4	25.8	--	114	128

1/ About 80 percent red mites on August 30 and 94 percent on September 7.

Rainfall between August 30 and September 17 totalled 1.71 inches. Although the 666 dust appeared about as effective as the DDT dust, when the 666 was applied as a spray it proved far less effective than the DDT spray and the residual efficiency on September 17 was largely due to old DDT deposits. The material should be tested further in other formulations but much testing on apples appears useless until an odorless preparation is available. The single spray seriously affected the flavor of apples harvested as late as October 1. The benzene hexachloride showed less toxicity to mites than DDT.

Rome Beauty

This variety was divided into 17 plots, each replicated 6 times on single trees in a restricted randomization. A seventh replicate of 2 trees was sprayed with 14 of the treatments and used to obtain the larvicidal efficiency and deposit data summarized in Table 3. Details of the spray treatments are given in Table 4.

Table 3. Average Percent Larvicidal Efficiency and Amount of Spray Deposits in mmgs. per Square Centimeter of Fruit Surface at Various Intervals After Spray Applications. Vincennes, Ind. 1945

Series 3. Rome Beauty

Plot	Formula (quantities per 100 gals.)		Interval between spraying and sampling (Deposits given in parentheses) 0 to 2 days	8 to 24 days	49 days
1	Lead arsenate, bordeaux, with oil in 4 sprays. Standard	As_2O_3	46.0 (17.1)	30.0 (8.8)	34.0 (8.8)
2	Lead arsenate, bordeaux, DDT-K, with oil in 4 sprays	As_2O_3	93.3 (7.9)	67.8 (4.5)	42.3 (2.4)
		DDT	(7.2)	(4.5)	(3.6)
3	As No. 2 except Deenate replaced DDT-K	As_2O_3	94.2 (7.3)	73.5 (4.1)	62.9 (2.2)
		DDT	(9.0)	(5.4)	(5.2)
4	Tank mix nicotine, Miss. bentonite, oil. Each at half strength	Nic.	75.4 (2.2)	49.0 (0.8)	53.5 (0.7)
5	Tank mix nicotine, Miss. bentonite. Standard	Nic.	83.9 (3.6)	69.4 (1.4)	54.2 (0.8)
6	6 ozs. DDT (as DDT-X) substituted for NS in No. 4 formula	DDT	79.3 (6.1)	53.4 (4.1)	29.6 (4.7)
7	6 ozs. DDT (as DDT-X) added to No. 4 formula	Nic.	95.2 (1.9)	68.9 (0.8)	42.3 (0.4)
		DDT	(6.0)	(3.8)	(3.2)
10	Same as 7 except Deenate substituted for DDT-X	Nic.	98.1 (1.9)	73.2 (0.7)	51.2 (0.4)
		DDT	(7.1)	(4.0)	(4.8)
11	NS 1/2 pt. DDT-Wyo. B. 2 lb., 14 oz., S. oil 1 qt.	Nic.	91.0 (2.2)	67.0 (1.0)	48.4 (0.7)
		DDT	(6.0)	(3.6)	(2.9)
12	B1. 155-DDT + 1 qt. OK oil	Nic.	93.4 (0.8)	61.1 (0.7)	31.0 (0.1)
		DDT	(6.8)	(4.1)	(4.6)
14	Deenate + 1 qt. OK oil	??	99.8	93.1	75.1
		DDT	(14.8)	(9.6)	(13.1)
15	DDT-P + 1 qt. OK oil	DDT	99.9 (17.1)	92.2 (10.4)	86.4 (11.6)
16	DDT-K + 1 qt. OK oil	DDT	99.2 (17.3)	84.8 (8.4)	75.1 (10.4)
17	No. 16 with DDT-K at double strength. 2 sprays omitted	DDT	99.7 (18.5)	86.7 (9.6)	68.8 (8.1)

Because of interplot migration of moths some weight must be given to differences in effectiveness shown by the data in Table 3 that do not appear in the final infestation data given in Table 5. The larvicidal efficiencies of Plots 1, 4, and 6 indicate that these treatments applied to larger acreages would have compared less favorably with the other plots than the data in Table 5 indicate.

There is no evidence that synergy resulted from the combination of DDT with nicotine bentonite (compare plots 4, 6, and 7) although the combination (7) was much more effective than the 6 ounces of DDT (6).

Deenate gave better results than DDT-kaolin (1:1) when added to either lead arsenate (3) or nicotine bentonite (10) probably because of the smaller particle size of its DDT. During the period when 6 ounces of DDT was used to supplement lead arsenate on plots 2 and 3 the DDT deposits on these two plots were almost identical with those on plots 6, 7 and 10.

The substitution of wettable sulfur for oil in the 4th and 5th cover sprays applied to plots 4 to 12 inclusive reduced the effectiveness of these treatments and made them compare less favorably with the others than they would under normal conditions.

As already indicated bentonite was added to the Plot 15 formula to prevent preferential wetting of the DDT and "buttering out" in the tank. DDT-kaolin and oil formed an inverted mixture under field conditions despite the addition of bentonite. Attempts to prevent this by the addition of more bentonite and later by building a by-pass into the pump-overflow and intake lines failed. It was prevented by including bordeaux in the fourth and fifth sprays and thereafter by adding a slurry of 2 ounces of lime and 2 ounces soybean flour per 100 gallons. The low efficiency of the DDT-kaolin-oil formulas compared with Deenate-oil was a result of this which was corrected before the principal codling moth attack occurred. Deenate-oil and some of the nicotine bentonite-DDT mixtures showed some tendancy to "invert" as the season advanced and warmer water was used hence similar adjustments were made in these formulas, the lime being omitted from tnose containing nicotine.

Field Testing of Insecticides on Randomized Plots

In addition to the plots arranged on the Rome Beauty variety some of the treatments were repeated on the Turley, Jonathan and Ben Davis varieties and additional treatments added. Seven cover sprays were applied on approximately the same schedule as for Rome Beauty except the final sprays were applied on August 2 and 3.

Details of the spray formulas are given in Table 4. Infestation data are summarized in Table 5. Also included in Table 5 are the DDT residues just prior to and during Rome Beauty harvest and at the first picking of the Turley and Ben Davis varieties.

Table 4. Spray Formulas Used in Small Plot Field Tests in 1945

Rome Beauty (17 treatments, single tree plots replicated 6 times)

Plot	Spray No.	Quantities of materials used per 100 gal.
1	1	LA 4 lb., Li. 2 lb., OK oil 1 pt., SF 4 oz.
	2-4	LA 4 lb., Bdx. 3/4, OK oil 2 qt.
	5	LA 4 lb., Bdx. 3/4
	6-7	LA 3 lb., Bdx. 3/4
2	1	LA 4 lb., Li. 2 lb., DDT-K 3/4 lb., OK oil 1 pt.
	2	LA 4 lb., Bdx. 3/4, DDT-K 3/4 lb., OK oil 2 qt.
	3-4	LA 2 lb., Bdx. 3/4, DDT-K 3/4 lb., OK oil 2 qt.
	6	Bdx. 3/4, DDT-K 2 lb.
	7	Bdx. 3/4, DDT-K 1-1/2 lb.
3	Same as Plot 2 except Deenate substituted for DDT-K	
4	1	NS 1/2 pt., X-415 4 lb., OK oil 1 pt.
	2-3,6-7	NS 1/2 pt., X-415 4 lb., OK oil 1 qt.
	4-5	NS 1/2 pt., X-415 4 lb., S. 3 lb.
5	1	NS 1 pt., X-415 8 lb., OK oil 1 qt.
	2-3,6-7	NS 1 pt., X-415 8 lb., OK oil 2 qt.
	4-5	NS 1 pt., X-415 8 lb., S. 3 lb.
6	1	DDT-X 30 oz., X-415 2-1/2 lb., OK oil 1 pt.
	2-3	DDT-X 30 oz., X-415 2-1/2 lb., OK oil 1 qt.
	4-5	DDT-X 30 oz., X-415 2-1/2 lb., S. 3 lb.
	6-7	DDT-X 30 oz., X-415 2-1/2 lb., OK oil 1 qt., SF 4 oz.

Table 4. (continued)

Rome Beauty (continued)

Plot	Spray No.	Quantities of materials used per 100 gals.
7		Combination DDT-nicotine bentonite. Same as 6 + 1/2 pt. NS
8		Same as 7 except X-415 reduced to 1/2 lb. or 2 lbs. altogether
9		Same as Plot 7 except equal quantities of soybean oil substituted for Orthol K. Soybean flour omitted
10	1	NS 1/2 pt., X-415 4 lb., Deenate 1-1/2 lb., OK oil 1 pt.
	2-3,6-7	NS 1/2 pt., X-415 4 lb., Deenate 1-1/2 lb., OK oil 1 qt.
	4-5	NS 1/2 pt., X-415 4 lb., Deenate 1-1/2 lb., S. 3 lb.
11	1	NS 1/2 pt., DDT-Wyo. B. 2 lb. 14 oz., S. oil 1 pt.
	2-3,6-7	NS 1/2 pt., DDT-Wyo. B. 2 lb. 14 oz., S. oil 1 qt.
	4-5	NS 1/2 pt., DDT-Wyo. B. 2 lb. 14 oz., S. 3 lb.
12	1	Bl. 155-DDT 3 lb., OK oil 1 pt.
	2-3,6	Bl. 155-DDT 3 lb., OK oil 1 qt.
	4-5	Bl. 155-DDT 3 lb., S. 3 lb.
	7	Bl. 155-DDT 3 lb., OK oil 1 qt., SF 2 oz.
13	1-3,6	Deenate 4 lb.
	4-5	Deenate 4 lb., Bdx. 1
	7	Deenate 3 lb.
14	1	Deenate 4 lb., OK oil 1 pt.
	2-3	Deenate 4 lb., OK oil 1 qt., 4 oz. KWK
	4	Deenate 4 lb., OK oil 1 qt., Bdx. 1
	5	Deenate 4 lb., Bdx. 1
	6	Deenate 4 lb., OK oil 1 qt., SF 2 oz., Li. 2 oz.
	7	Deenate 3 lb., OK oil 1 qt., SF 2 oz., Li. 2 oz.
15	1	DDT-P 2 lb., OK oil 1 pt., KWK 4 ozs.
	2-3,6	DDT-P 2 lb., OK oil 1 qt., KWK 4 oz.
	4	DDT-P 2 lb., OK oil 1 qt., Bdx. 1
	5	DDT-P 2 lb., Bdx. 1
	7	DDT-P 1-1/2 lb., OK oil 1 qt., KWK 4 ozs.
16	1	DDT-K 2 lb., OK oil 1 pt.
	2-3	DDT-K 2 lb., OK oil 1 qt., KWK 4 ozs.
	4	DDT-K 2 lb., OK oil 1 qt., Bdx. 1
	5	DDT-K 2 lb., Bdx. 1
	6	DDT-K 2 lb., OK oil 1 qt., SF 2 oz., Li. 2 oz.
	7	DDT-K 1-1/2 lb., OK oil 1 qt., SF 2 oz., Li. 2 oz.
17	1	DDT-K 4 lb., OK oil 1 pt., KWK 4 ozs.
	2-3	DDT-K 4 lb., OK oil 1 qt., KWK 8 ozs.
	4	DDT-K 4 lb., OK oil 1 qt., Bdx. 1
	7	DDT-K 3 lb., OK oil 1 qt., SF 2 oz., Li. 2 oz.

Table 4 (continued)

Jonathan (Paired trees in filler row adjacent to Rome Beauty plots, 3 replicates)

Plot	Spray No.	Quantities of materials used per 100 gals.
38		Same as Rome Beauty Plot 5
39	1-6	Dust. DDT-Pyrax-DN 4 dust (5:10:85), 2-3 lbs. per tree
	7-10	Dust. DDT-Walnut shell flour (5:95), 2-3 lbs. per tree

Turley (11 treatments, single tree plots replicated 5 times)

1		Standard lead arsenate. Same as Rome Beauty 1
5		Standard tank mix nicotine bentonite. Same as Rome Beauty 5 except sulfur was not substituted for oil
7	1	NS 1/2 pt., DDT-X 30 oz., X-415 2-1/2 lb., OK oil 1 pt.
	2-4	NS 1/2 pt., DDT-X 30 oz., X-415 2-1/2 lb., OK oil 1 qt.
	5-7	NS 1/2 pt., DDT-X 30 oz., X-415 2-1/2 lb., OK oil 1 qt. SF 4 oz.
13		Deenate. Same as 13 on Rome Beauty except bordeaux used in third instead of fourth and fifth sprays.
18	1-5	Same as Plot 19
	6-7	Same as Plot 7 (Turley)
19	1	LA 2 lb., LA-DDT 2 lb. 6 oz., Li. 2 lb., OK oil 1 pt., SF 4 oz.
	2	LA 2 lb., LA-DDT 2 lb. 6 oz., Bdx. 3/4, OK oil 2 qt.
	3-4	LA-DDT 2 lb., 6 oz., Bdx. 3/4, OK oil 2 qt.
	5-7	LA-DDT 2 lb. 6 oz., Bdx. 3/4
21	1-2,4-6	DDT-K 2 lb.
	3	DDT-K 2 lb., Bdx. 1
	7	DDT-K 1-1/2 lb.
22	1-2,4-6	DDT-P 2 lb.
	3	DDT-P 2 lb., Bdx. 1
	7	DDT-P 1-1/2 lb.
23	1-2,4-6	DDT-paste (1 lb. DDT)
	5	DDT-paste (1 lb. DDT), Bdx. 1
	7	DDT-paste (3/4 lb. DDT)
24	1-2,4-6	G-AK-40 2-1/2 lb.
	5	G-AK-40 2-1/2 lb., Bdx. 1
	7	G-AK-40 30 oz.
25	1-2,4-6	17% DDT 6 lb.
	5	17% DDT 6 lb., Bdx. 1
	7	17% DDT 4-1/2 lb.

Table 4 (continued)

Ben Davis (14 treatments, single-tree plots replicated 5 times)

Plot	Spray No.	Quantities of materials used per 100 gals.
1		Standard lead arsenate. Same as Rome Beauty 1
5		Standard tank mix nicotine bentonite. Same as Turley 5.
36		Same as 5 except Panther Creek Mississippi bentonite substituted for X-415
13		Deenate. Same as 13 on Turley except bordeaux was used only in 2nd spray
26	1	Deenate 4 lb.
	2-6	Deenate 4 lb., Bdx. 1
	7	Deenate 3 lb., Bdx. 1
27	1	DDT-K 2 lb.
	2-6	DDT-K 2 lb., Bdx. 1
	7	DDT-K 1-1/2 lb., Bdx. 1
28	1,3-6	DDT-B 2 lb.
	2	DDT-B 2 lb., Bdx. 1
	7	DDT-B 1-1/2 lb.
29	1-5	Same as 28 + Uramon 2 lb.
	6	DDTA 1 lb. (ground in Mikropulverizer with water), S. oil 1 qt., SF 4 oz., Li. 4 oz.
	7	DDTA 3/4 lb., S. oil 1 qt., SF 4 oz., Li. 4 oz.
30	1,3-6	DDT-FE 2 lb.
	2	DDT-FE 2 lb., Bdx. 1
	7	DDT-FE 1-1/2 lb.
31	1,3-6	DDT-PC 5 lb.
	2	DDT-PC 5 lb., Bdx. 1
	7	DDT-PC 3-3/4 lb.
32	1	DDT-xanthone (1:2) 2 lb., soybean phosphatides 2 oz.
	2-7	DDT-xanthone (1:2) 2 lb., Genefilm A 6 oz., Genefilm B 2 oz., kerosene 3 pt.
33	1	DDT-paste (1 lb. DDT), S. oil 1 pt., KWK 1 lb.
	2-3	DDT-paste (1 lb. DDT), S. oil 1 qt., KWK 1 lb.
	4-6	DDT-paste (1 lb. DDT), S. oil 1 qt., SF 4 oz., Li. 4 oz.
	7	DDT-paste (3/4 lb. DDT), S. oil 1 qt., SF 4 oz., Li. 4 oz.
34	1-6	DDT 1 lb. in 1-1/2 pt. benzene and 1 qt. S. oil, KWK 8 oz.
	7	DDT 3/4 lb. in 18 oz. benzene and 1 qt. S. oil, KWK 8 oz.

Table 4. (continued)

Ben Davis (continued)

Plot	Spray No.	Quantities of materials used per 100 gal.
35	1	DDT 1 lb. in 2 lb. benzene plus 0.5 oz. B-1956
	2-5	DDT 1 lb. in 2 lb. 10 oz. benzene plus 0.5 oz. B-1956
	6	DDT 1 lb. in 2 lb. 10 oz. xylene plus 0.5 oz. B-1956
	7	DDT 3/4 lb. in 2 lb. xylene plus 0.5 oz. B-1956
40	Dust plot. Single 9-tree plot 1/4 mile from above plots. 10 appls.	
	1-10	DDT-R-N dust, 2.5 lb. per tree per appl.
41	Nicotine bentonite spray program applied by grower to block adjacent. to Plot 40.	
	1	NS 1 pt., KWK 5 lb., S. oil 1 pt.
	2	NS 1 pt., KWK 5 lb., S. oil 1 qt.
	3,8-9	NS 1 pt., X-415 8 lb., Gulf 301 oil 2 qt.
	4	NS 1 pt., Kolofog bentonite-sulfur 6 lb.
	5-6	NS 1 pt., X-415 3 lb., Kolofog 3.6 lb.
	7	NS 1 pt., X-415 8 lb., S. oil 1 qt.
	10-11	NS 1 pt., X-415 8 lb., OK oil 2 qt.

On Rome Beauty all formulas containing DDT gave results superior to those obtained with the standard nicotine bentonite and lead arsenate programs. The combination nicotine bentonite-DDT programs compared less favorably with straight DDT (13) and lead arsenate-DDT than in 1944 partly because the latter utilized full strength DDT in the last two sprays, sulfur replaced oil on the nicotine DDT plots in two important midseason sprays, and because the amount of oil used was reduced to 1/4 percent from the 1/2 percent used previously. Another factor may be the grinding of DDT with Mississippi bentonite since recent investigations by Mr. Fahey suggest that DDT in this mixture is more subject to decomposition than in any of the others tested. Plots 10 (Deenate and nicotine bentonite) and 11 (DDT-Wyoming bentonite) were not significantly different from Deenate alone (13).

The combination treatments and Deenate alone did not leave excessive residues, as did treatments 14 to 17 inclusive.

On Jonathans and Ben Davis ten applications of 5 percent DDT dust proved much less effective than the standard nicotine bentonite program with which it was compared. Also, the dust treatment on these varieties was less effective than any spray treatment on any varieties.

Table 5. Results of Small Plot Field Tests. Vincennes, Ind. 1945

No.	Treatment (for details see Table 4)	Apples per tree Number	Worms per tree June 25-26 Number	Seasonal data: Clean apples[1] Percent	Seasonal data: Worms per 100 apples Number	DDT residue in PPM 9/14	DDT residue in PPM 9/27
	Rome Beauty						
1.	Std. LA, Bdx., oil	26	3	90.5	6.6	-	-
2.	LA, Bdx., oil, DDT-K	21	0	97.3	2.2	3.9	3.5
3.	LA, Bdx., oil, Deenate	23	1	97.6	1.3	5.3	4.8
4.	Nic. bent. oil, 1/2	28	21	84.6	15.2	0	-
5.	Std. Nic. bent. oil	17	1	91.3	8.3	-	-
6.	6 ozs. DDT as DDT-X, bent., oil	22	4	93.4	4.8	4.7	4.0
7.	No. 6 + 1/2 pt. NS	23	0	94.9	3.4	3.5	3.4
8.	Same as 7 except X-415 reduced 1/2	21	1	94.6	3.5	-	-
9.	Same as 7 except S. oil replaced OK oil	22	0	93.5	5.2	-	2.8
10.	Same as 7 except Deenate replaced DDT-X	19	0	96.3	2.1	5.0	4.4
11.	DDT-Wyo. B., NS 1/2 pt.,SO	28	0	97.5	1.8	3.0	3.3
12.	Bl. 155-DDT, oil	20	3	92.0	6.3	4.5	5.3
13.	Deenate	33	0	97.5	1.4	-	4.8
14.	Deenate + oil	26	0	98.2	0.7	13.2	10.0
15.	DDT-Pyrax + oil	26	0	98.6	0.4	12.0	12.8
16.	DDT-kaolin + oil	27	0	98.2	0.7	10.8	10.6
17.	No. 16 with DDT doubled. 2 sprays omitted	22	0	97.1	1.1	8.4	9.8
	Jonathan						
38.	Std. Nic. Bent. Oil (As No. 5)	14	0	91.3	5.7	-	-
39.	DDT 5% dust 10 applications	19	43	61.7	52.5	-	-

Table 5 (continued)

No.	Treatment (for details see Table 4)	C Apples per tree Number	Worms per tree June 25-26 Number	Seasonal data Clean apples[1] Percent	Seasonal data Worms per 100 apples Number	DDT residue in PPM 9/20
Turley						
1.	Std. LA, Bdx. oil	15	14	82.8	11.8	-
5.	Std. Nic. Bent. Oil	9	6	88.7	9.9	-
7.	Combination DDT, NB, Oil	9	1	94.6	3.8	6.3
13.	Deenate	28	0	96.0	2.7	8.6
18.	No. 19 in 5 sprays, No. 7 in 2	15	0	97.6	0.9	6.8
19.	DDT-LA, Bdx., Oil	13	1	98.4	1.1	6.0
21.	DDT-kaolin	20	4	94.3	4.3	6.7
22.	DDT-Pyrax	20	0	97.5	1.8	7.4
23.	DDT-paste	17	0	86.3	9.6	5.2
24.	G.-AK-40 DDT	18	0	97.9	1.7	7.9
25.	DDT-17%	24	0	97.5	0.9	11.3
Ben Davis						10/15
1.	Std. LA, Bdx., Oil	11	3	56.9	40.6	-
5.	Std. NB, Oil	12	2	86.1	11.7	-
36.	Same as 5 except PC bentonite used	10	3	84.8	13.8	-
13.	Deenate	10	0	91.6	2.8	7.1
26.	Deenate + Bdx. 1	11	0	93.2	2.9	7.2
27.	DDT-K + Bdx. 1	11	0	89.3	8.2	5.7
28.	DDT-Bancroft clay	13	0	92.9	1.8	6.5
29.	Split DDT-B + Uramon and DDTA + S. oil	9	0	92.6	0.9	10.3
30.	DDT-Fullers earth	14	0	85.4	8.9	4.3
31.	DDT-PC	11	1	93.2	1.5	8.2

Table 5. (continued)

No.	Treatment (for details see Table 4)	C Apples per tree Number	Worms per tree June 25-26 Number	Seasonal Data Clean apples[1] Percent	Seasonal Data Worms per 100 apples Number	DDT residue in PPM 10/15
	Ben Davis (continued)					
32.	DDT--xanthone 1:2	14	0	90.1	5.1	4.9
33.	DDT-paste + S. oil	12	0	92.4	1.7	10.9
34.	Emulsion. DDT-benzene + S. oil	14	0	96.5	0.4	17.8
35.	Emulsion. DDT-benzene or xylene	14	1	93.9	1.1	10.1
	Single 9-tree plots. Ben Davis					
40.	Dust. DDT-R-N, 10 appls.	24	92	33.1	113.0	2.8
41.	Std. MB, Oil, 11 sprays by grower	17	28	74.7	24.0	-

1/ Apples free from codling moth entrances or stings.

On the Turley variety the DDT paste gave very poor results as compared to other DDT formulations with which it was compared, probably because of the large size of its DDT particles. However, it was as effective as either lead arsenate or standard nicotine bentonite. Excellent results were obtained with the split schedule used on Plot 18 with less foliage injury than on plots 1 and 19. DDT-Pyrax and DDT-17 percent left no visible residues. Those from Deenate and Geigy's AK-40 retarded coloration and could not be removed by brushing. On this variety the combination programs did not leave excessive residues while the more effective of the straight DDT programs did.

On Ben Davis, Bordeaux, although it did not reduce the effectiveness of Deenate (13 vs. 26), caused serious foliage injury and russetting on plots 1, 26 and 27. Somewhat less severe foliage injury developed on Turley and Rome Beauty plots that received Bordeaux in all sprays but defoliation from copper injury was serious on all varieties.

Excellent results were obtained with DDT-Bancroft clay (28), the aerosol DDT paste with soybean oil in the second brood sprays (29), DDT-PC "impregnated" (31), the DDT paste with soybean oil (33) and the two emulsions (34, 35). Addition of soybean oil to the DDT paste apparently offset the adverse effect of its larger particle size.

The emulsions and the pastes left no visible residue, caused no injury, and gave the fruit an excellent finish but their harvest residues were excessive.

The DDT-xanthone caused very serious russet and the fruit, instead of turning red, was mostly yellow at harvest. This combination may be safe in late applications, since most of the russet developed early in the season.

Effect of Different Spray Programs on Mites and Spiders

A thorough application of a 3 percent oil spray in March, along with adverse weather conditions delayed the appearance of mites and spiders until early July and as a result severe bronzing developed on only a few trees.

However, by September 10 the numbers of mites and spiders on the Turley plots ranged from 994 per 100 leaves on plot 5 to 5,780 on plot 19. Bronzing, however, was most severe on plot 13 where the population on July 5 averaged 136 per 100 leaves, more than 5 times that of any other single plot. This plot had been sprayed with DDT alone in 1944.

On Ben Davis, the mites and spider infestations were negligible. On certain Rome Beauty plots, as shown in Table 6, they developed at an unprecedented rate after their first appearance on July 4.

Table 6. Average Mite and Red Spider Populations 1/ on Plots Grouped according to Type of Spray Program. Variety: Rome Beauty. Vincennes, Indiana - 1945

Plots	Type of Program	Species	Average number adults and nymphs per 100 leaves		
			July 4	Aug. 9	Sept. 12
1	Lead ars. Oil in first 4 sprays	ERM	4	530	176
		CRS	-	2,556	2,390
2 and 3	DDT (6 oz.) with LA and oil in first brood sprays, DDT 3/4-1 lb. later	ERM	2	433	330
		CRS	-	1,004	8,016
4 and 5	Half and full strength nicotine bentonite, oil	ERM	2	199	100
		CRS	-	805	441
6 to 11	DDT (6 oz.) bent., oil with or without reduced nicotine	ERM	1	389	218
		CRS	-	971	3,232
12	B1. 155-DDT (8 oz.) with oil	ERM	2	231	218
		CRS	-	910	4,245
13	DDT standard strength	ERM	0	2,058	94
		CRS	-	992	5,759
14 to 16	As No. 13 + 1/4% oil	ERM	3	147	239
		CRS	-	275	12,678
17	DDT double strength + oil, 2 sprays omitted	ERM	0	724	329
		CRS	-	538	10,510

1/ The mite collecting apparatus and technique developed by Henderson (USDA Circular 671, 1943) were used in determining the mite populations. Samples of 15 or 20 leaves per tree were taken from the six trees in each plot. No mites or spiders were found in the June 11 and earlier examinations. Red spiders were not counted on July 4 because they were even less abundant than the red mites.

On August 9, 12 days after the last spray, the largest red spider and third largest red mite populations were found on the standard lead arsenate plot proving rather definitely that the red mite and red spider build-up was not due to the effect of DDT on the foliage. On that date the heaviest red mite infestation was present on the straight DDT plot (13), the only plot on which no oil was used in the early sprays. This plot contained trees on which DDT had been used in 1944.

The smallest population of each species was present on the three plots sprayed with DDT and 1/4 percent oil. Omission of the fifth and sixth covers from plot 17 resulted in too wide a spacing of sprays to hold the mites in check. Since plots 14 to 16 had the heaviest DDT residues and since the numbers of red spiders on these plots increased tremendously during the 34 day period between August 9 and September 12 it must be assumed that the DDT-oil treatments were highly toxic to mites when applied but that their residual toxicity was low.

Stethorus punctum, an important predator, began appearing in mid August. On September 12, larvae and pupae of S. punctum averaged 15 per 100 leaves on plot 1, 30 on plots 2 and 3 and from 8 to 14 on the others.

Part of the late increase in red spiders was due to movement up into the trees and wind drift rather than reproduction.

It is apparent that although near annihilation of first-brood codling moth and the red mite population with DDT-oil sprays might be possible, such a program here would require later spraying to control red spiders. Of the formulas containing DDT the combinations with nicotine bentonite gave the least trouble from mites and spiders even though only 1/4 percent oil was used.

Experiments with Midseason Sprays to Control Mites and Spiders

Tests were arranged on randomized plots of two trees, one each of the Rome Beauty and Starking varieties. The 46 trees used were in a block which was sprayed with DDT in 1944 and which had already received 5 DDT sprays in 1945. Experimental treatments were applied on July 20 and 30. Mite and spider populations were determined for each tree on July 20 just before the first spray application and thereafter on July 25, August 3 and August 17. The residual efficiency of the two sprays against codling moth was determined on September 6. The results of representative treatments are given in Table 7.

Table 7. Comparative Effect of Two Midseason Sprays on the Red Mite and Red Spider Populations. Vincennes, Ind. 1945

	Formulas applied July 20 and 30 Quantities are for 100 gal.	Mites and spiders per 100 leaves on 7/20	Increase or decrease compared with numbers present July 20			Residual efficiency against CM on Sept. 6	Average DDT per sq. cm. Sept. 6
			7/25	8/3	8/17		
		Number	%	%	%	%	mmgs.
1	No additional sprays (check)	1,492	+198	+270	+840	0	5.1
2	DDT 2 lb. (Av. of 2 plots)	697	-23	+ 79	+654	-	-
3	DDT 1 lb. (Av. of 2 plots)	1,205	+ 19	+105	+430	81	11.8
4	No. 3 + 4 qt. mineral oil 1/ (2 plots)	1,450	- 93	- 92	- 46	95	22.3
5	No. 3 + 1 qt. mineral oil 1/ (2 plots)	2,031	- 55	- 80	+ 15	96	20.9
6	Mineral oil 4 qt. (2 plots)	957	+ 37	- 54	+228	-	-
7	Mineral oil 6 qt.	523	- 32	- 81	+198	10	9.6
8	DDT 6 oz., NB 1/2 strength, 4 qt. oil 1/	1,884	- 83	- 97	- 17	72	11.2
9	DDT 1 lb., DN-111, 1-1/4 lb.	2,308	- 97	- 95	- 51	73	12.4
10	DDT 1 lb., HMF 25%, 4 lb.	1,740	- 93	- 88	- 58	92	14.2
11	DDT-xanthone (1:2) 2 lb., Kerosene 3 pt.	1,484	- 90	- 94	- 53	56	9.8
12	1 pt. NS, 8 lb. X-415, 4 qt. OK oil	878	- 51	- 31	+265	74	6.2

1/ With supplements added to prevent preferential wetting of the DDT by the oil.

It is evident that DDT is toxic to mites and spiders and that this toxicity was greatly increased when oil was added since 1/4 percent oil with 1 pound DDT gave more effective control than 6 quarts of the oil alone.

No spray injury resulted on any of the plots except for some burning of the DN-111 plot and on a weak limb on one of the trees sprayed with hydroxy methyl flavan.

Large Scale Tests of DDT

Large scale comparisons of several DDT spray programs were made in cooperation with Mr. M. P. Reed at Vincennes and Mr. C. R. McCollom at Henderson, Ky. All sprays were applied by the growers.

In the Reed orchard 177 acres were divided into 7 blocks in which 4 different spray programs were used. Three of the blocks were sprayed from a stationary plant by hand and three with a Speed Sprayer. The same three spray programs were used in each set of blocks. Both types of equipment were used in the seventh block.

Stratified samples of 200 apples each were examined on 230 trees representing at least 4 varieties in each block between August 25 and 31. Samples of drops were also examined.

The results are summarized below:

Treatment 1/	Acres	Cover sprays	Average of Varieties Examined: Clean apples	Worms per 100 apples	Mites and spiders per leaf, Aug. 20	Range in DDT residues at harvest
	Number	Number	Percent	Number	Number	PPM
A	28	10-1/2	80.4	15.6	4	0
B	53	10	92.4	3.9	11	3.7-9.8
C	51	7	93.1	2.7	19	5.7-8.5
D	45	9	91.3	3.8	2	4.2-9.0

1/ A - Standard nicotine bentonite, oil. Sulfur substituted for oil in three midseason sprays. Final spray August 6.

B - Half strength nicotine bentonite, oil + 6 ounces DDT. Sulfur substituted for oil in three sprays. Final spray August 7.

C - DDT, 1-1/2 pounds (actual basis) in two sprays, 1 pound in 3, 1/2 pound in 2. Oil added to 5 sprays. Final spray July 30.

D - Single block. Six sprays of DDT (6 ounces) with lead arsenate, bordeaux and oil. Three sprays of DDT at 1/2 pound with oil in 2.

Consistently poorer results were obtained with each of the A, B, and C programs when applied with the Speed Sprayer than when applied by hand even though approximately the same amount of spray was applied per tree by the two methods. Comparative results were as follows:

	Number of Worms per 100 Apples		
	A (Nic. B.)	B (NB-DDT)	C (DDT)
Speed Sprayer	25.8	6.1	3.5
Hand Sprayed	5.5	1.7	2.0
Ratio, SS:HS	4.7:1	3.6:1	1.8:1

In order to check on the reliability of the infestation counts made on the trees late in August, seven well distributed Winesap trees in each of six of the plots were selected in August and thereafter samples of all drops and picks were examined in the usual manner. There was only a 5 percent increase in codling moth injuries in the B areas between August 25 and October 19. In the C areas, however, there was no increase in the area sprayed by hand but a 128 percent increase in the block where the Speed Sprayer had been used.

In part of the C area where DDT had been used on an 8-acre plot in 1944, the mite infestation averaged 95 adults and nymphs per 100 leaves on June 30 or 24 times that on trees of the same 4 varieties outside the plot. By July 19 the mites and spiders had increased to 1,040 per 100 leaves and were then 11 times as abundant as they were on nearby trees. On August 20 they averaged 5,547 inside and 2,351 outside the plot. This is strong evidence that use of DDT over a period of several years may lead to an increasingly difficult mite problem.

The grower applied a 3 percent dormant oil spray in two one-side applications to part of the A, B, and C areas and all of the D area. The dormant spray had the effect of delaying mite and red spider build-up approximately 30 days and on August 20 the average populations per 100 leaves in the B and C areas were as follows:

	Dormant spray	No dormant spray
European red mites	607	1,269
Common red spiders	862	3,164

Insects known or believed to be mite predators and which were knocked down on collecting tables in the different DDT sprayed areas included S. punctum, other coccinellids, Triphleps insidiosus, chrysopids, and beetles of the genus Notoxus. A few Pselaphidae were also found.

An estimated 1,000 Chrysopid adults per tree were knocked down in a dust plot (40) between July 15 and August 31. Ten days after the 6th cover spray in the C area Triphleps insidosus were found dead on the tables at the rate of 100 per tree per day. No predacious mites were observed on any of the many leaf samples collected.

In the Henderson, Ky., experiments, an orchard of 36 acres in three partially isolated plantings was divided into six paired plots. The results based on examinations of 2 to 3 varieties per plot follow:

Treatment 1/ Paired Blocks	Acres	Date of final spray	CM injuries per 100 apples		Mites and spiders per leaf 8/21
			Worms	Stings	
	No.		No.	No.	No.
A-1	8	8/4	4.6	4.2	0.1
C-1	10	7/24	0.4	1.4	0.1
B-1	5	7/24	1.4	2.6	9.0
C-2	5	7/24	0.2	0.8	4.0
A-2	3.3	8/4	5.8	7.1	0.1
C-3	4.7	7/24	0.3	1.0	2.0

1/ All plots were given a double calyx and 1-1/2 cover sprays of lead arsenate and sulfur before the following programs were started.

A - Nicotine bentonite, oil. 9-1/2 cover sprays.

B - 1/2 strength nicotine bentonite, 1/2 percent oil, 6 ounces DDT. Seven cover sprays.

C - Lead arsenate, Bordeaux, oil, DDT (6 ounces) 3 sprays. DDT 1 pound, Bordeaux and oil 1/2 percent in 3 sprays. DDT 1 pound, oil 1/4 percent in seventh.

Although the best control of codling moth was obtained with the C program the final spray caused very severe foliage injury within 24 hours. It was applied in hot humid weather but the mixture is believed to have partially "inverted" and acquired strong deposit building tendancies. On October 1 the DDT residue on Winesaps in the C area was 15.3 PPM compared to 7.4 PPM in the B area. No mites or spiders could be found in this orchard prior to August 21. Some damage from red spiders subsequently developed in the B area on lower inside branches of scattered trees but in general, the foliage condition, color, and quality of the fruit in the B blocks was far superior to that in the C blocks.

The use of DDT in the large scale tests resulted in no detectable increases in fruit pests other than red mites and red spiders. Leafhoppers were conspicuously absent from DDT sprayed blocks. The straight DDT program applied to the C areas in the Reed orchard gave almost complete control of Aphis pomi which was very abundant in the A areas sprayed with nicotine bentonite, particularly where the A areas adjoined the C.

Preferential Wetting of DDT by Oils

When suspensions of mechanically mixed, coated, or impregnated DDT formulations are used in mixtures containing spray oils the DDT has a strong tendancy to become preferentially wet by the oil. This is brought about principally by agitation of the spray mixture and as agitation continues the oil-wet DDT particles in the early phases may have strong deposit building properties. They may also clump together in increasingly larger masses and either float on top as soon as agitation ceases or sink to the bottom of the tank. They may be sprayable in the early stages and reach a putty-like consistency and clog the sprayer filter later. The occurrence of this condition and the consistency of the oil-wet material varies with the ratio of DDT to oil, with temperature and possibly with hardness of the water, amount of agitation (time and speed), type of DDT formulations, oils used and the wetting or emulsifying agents they contain, and type or amount of supplemental materials added to the mixture.

Because of the need for oil in DDT-nicotine bentonite mixtures, growers have had and will continue to have failures with certain formulations unless preferential wetting of the DDT is prevented either by the addition of soybean flour or Wyoming bentonite or by other means. In 1944 the use of a deposit building DDT-Fermate-oil mixture caused severe defruiting and defoliation. The combination of Deenate and oil, without a supplement to prevent the formation of an inverted mixture, caused severe injury following the only such application made in the Henderson, Ky. experiments. The same DDT-oil combination used with a slurry of lime and soybean flour at Vincennes caused no injury when applied on several occasions under similar weather conditions.

Experiments with Moth Poisons Applied at Dusk

Orchard tests with moth poisons applied at dusk which were begun in 1943 were continued in 1945. The same 3.6 acre or 8 x 20 tree blocks (orchard 8 rows wide) were again employed. In both 1943 and 1944 most of the reduction in infestation was obtained early in the season.

In 1945 the orchard was left unsprayed by the grower until mid July, and a packing shed between the B and C blocks was left unsealed. The sprays of 1:1200 nicotine sulfate and water were applied on 14 evenings between July 14 and August 18 at the rate of about 1/2 gallon per tree. The 7.2 acres were sprayed within a 10 minute period with a truck-mounted sprayer having an overhead cluster of 4 guns arranged so that 2 rows could be sprayed simultaneously. After mid season the grower tried to salvage part of his crop by using DDT and lead arsenate or nicotine bentonite in several sprays. This was applied to all blocks alike.

Infestation counts were made on 7 trees in each of the 4 plots at the end of first-brood attack before starting the sprays, and again late in August. Five bait traps were operated in each plot.

The infestations for the three seasons were as follows:

	Codling moth injuries per 100 apples and treatment							
	Final 1943		1944			1945		
Blocks	infestation		6/19		Final		6/25	8/29
A, C	Check	314	Treated	34	103	Treated 1/	62	148
B, D	Treated	182	Check	47	155	Check	49	168
Infestation in treated compared with that in check		-42%		-28%	-34%		+27%	-12%

1/ Not sprayed in 1945 until after July 14.

The infestations on June 25, 1945 indicate that moth movement more than nullified the difference that existed at harvest in 1944 and that the A and C blocks normally contain a heavier infestation. It was for this reason that the sprays were applied to the same blocks as in 1944. The 14 dusk applications cost less than 10 cents per tree for labor, depreciation and materials. Although the infestation in

the treated plots was only 12 percent less than in the controls, injuries increased 139 percent between June 25 and August 29 in the treated blocks while they were increasing 243 percent in the controls.

The numbers of moths caught in bait traps were as follows:

	April 21-July 14	July 14-Aug. 18	Aug. 18-31
Blocks A, C	1,749	2,319	454
Blocks B, D	1,495	2,554	335

As soon as spraying ceased the moth population, as a result of moth migration, again built up to a higher level in the A and C blocks than in the others.

Distribution and Survival of Hibernating Larvae

Time was available in 1945 for a detailed examination of only 5 mature trees. The distribution of surviving larvae in late March and early April was as follows:

Average number alive per tree 74.4

Percent in debris on ground 31.4

Percent under bark on tree 32.3

Percent in cavities and crevices 30.6

Percent in stubs and breaks 5.6

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Laboratory Experiments with Insecticides

As in past years, laboratory studies were continued in an effort to find chemicals that would be of value for insecticidal usage. This research included compounds of synthetic origin as well as extracts from plant materials. For the most part lead arsenate has been used as the standard for comparison, but in some instances DDT was employed.

The laboratory studies were made with the apple-plug method, using about 100 plus per test. Each plug was infested with a single-ready-to-hatch codling moth egg. The materials were usually tested at a rate of 4 pounds per 100 gallons and were applied by means of a compressed-air sprayer.

Synthetic organic compounds:

Compounds of this class were submitted by the Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine, for evaluation against the codling moth. Only a few of them showed greater effectiveness than lead arsenate and these were distinctly inferior to DDT.

A limited amount of work was done with benzene hexachloride. The material tested was of British origin and contained a comparatively low percentage of the gamma isomer. Our results show that the initial effectiveness of benzene hexachloride is very satisfactory when it is used at a rate to give 1 pound of the gamma isomer in 100 gallons of spray. Residual effectiveness has not been studied.

Laboratory tests of DDT - oil sprays:

Various formulations of DDT dissolved in oils were tested. These contained from 5 to 30 percent of DDT in solution. The latter consisted of DDT, 30 percent by weight, dissolved in a carrier, 70 percent by weight, made up from acetone 50 percent, red engine oil 25 percent and soybean oil 25 percent.

For the most part, the DDT-oil solutions were atomized into a spray chamber with compressed air at 50 pounds. An exceedingly fine fog was obtained, which was used to expose both whole apples and apple plugs for different time periods. Comparatively low residue loads of DDT were very effective when applied in this manner.

Organic-inorganic compounds:

The Eastern Regional Research Laboratory of Philadelphia, Pa., submitted a number of compounds, mostly metallic-nicotine ones for evaluation. These were compared with nicotine sulfate, nicotine-bentonite (Black Leaf 155) and with certain cyanides and thiocyanates. The resulting data, which follows, cover conditions in which the larvae hatched a few hours after the spray application.

Spray Material		Percentage Apple Plugs Wormy	Stung
Nicotine sulfate (40% N)	0.05% Nicotine	1	1
Cuprous Nicotine thiocyanate	Do	3	2
Cuprous Nicotine cyanide	Do	11	5
Cuprous Nicotinammino thiocyanate	Do	20	4
Oil-soluble Nicotine in coconut oil acids	Do	27	10
Nicotine-bentonite (Black Leaf 155)	Do	36	9
Nicotine (alkaloid)	Do	41	9
Cuprous nicotinammino iodide	Do	44	6
Zinc nicotine thiocyanate	Do	62	6
Cuprous cyanide (commercial)	4-100	80	0
Zinc cyanide	Do	80	3
Cuprous thiocyanate	Do	86	2
Lead arsenate	Do	63	11
Check (no treatment)		89	2

Nicotine sulfate and cuprous nicotine thiocyanate were about equal in effectiveness. Doubtless nicotine (alkaloid) would have shown the same effectiveness had it not volatilized as quickly.

Insecticides from plant materials:

The results of tests against a number of insects of nicotine, nornicotine, and anabasine have been reported by various workers. In the light of our present knowledge these tests were not made with chemically pure compounds. In order to evaluate their initial effectiveness in pure form, C. V. Bowen, Division of Insecticide Investigations, Bureau of Entomology and Plant Quarantine, prepared them for tests against codling moth larvae. These plant extracts were compared directly with freshly precipitated DDT (technical) as well as lead arsenate.

The results obtained with three tests of each material are as follows:

Spray Material		Percentage Apple Plugs Wormy	Stung
Nicotine	0.05%	16	4
Nornicotine	0.05%	83	1
Anabasine	0.05%	85	1
DDT	0.05%	52	20
Lead arsenate	4-100	63	5

As is already recognized, and further confirmed by these tests, nicotine is one of the most toxic of known insecticides when freshly applied against codling moth larvae. Its initial effectiveness was far superior to the other alkaloids used in these tests as well as to DDT and lead arsenate at the concentrations shown in the table.

Studies on olfactory attractants for codling moth larvae:

Laboratory tests of various synthetic organic compounds at different dilutions were made with the object of finding a material that would attract newly hatched codling moth larvae. None of the materials were attractive.

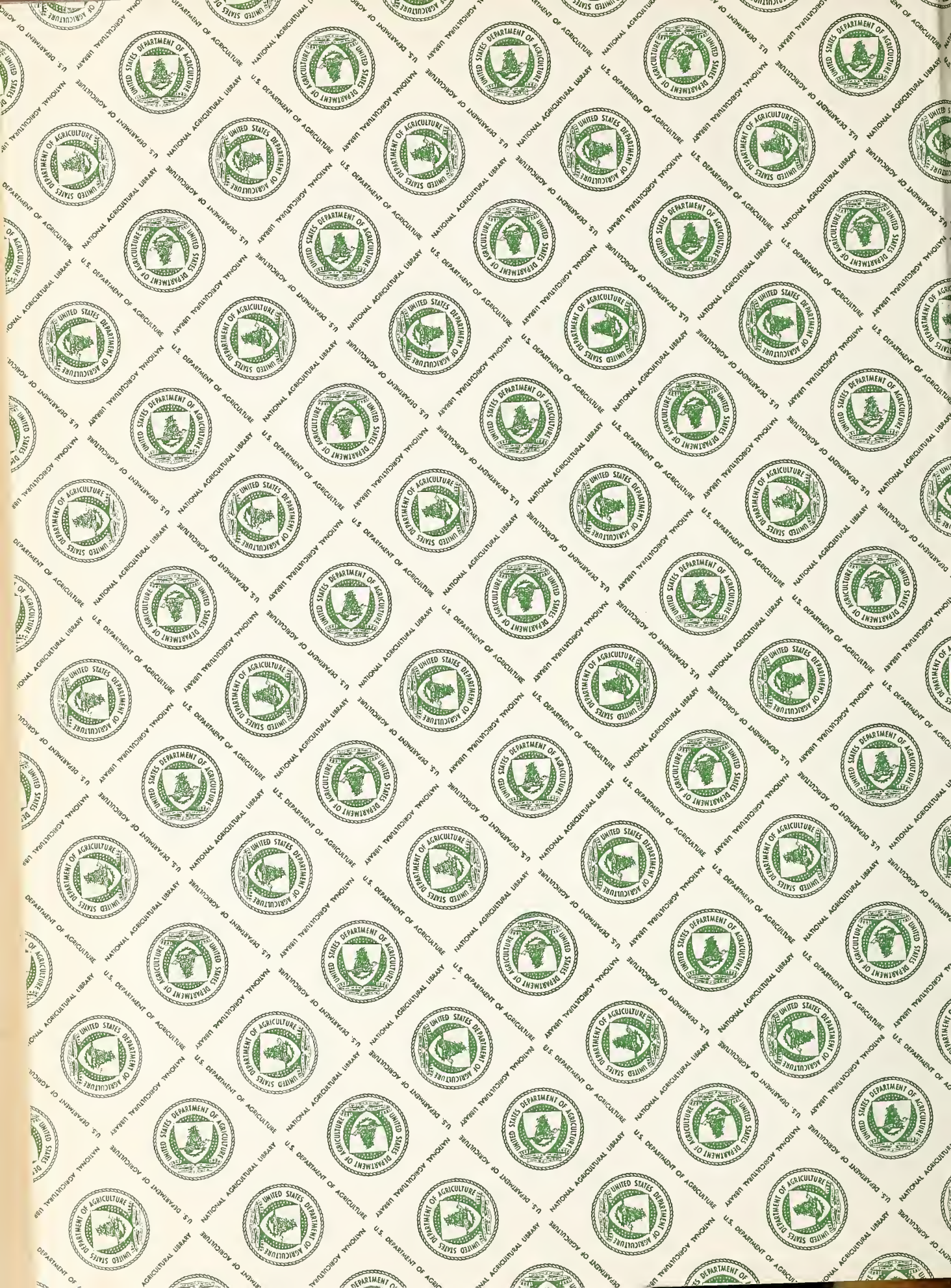
Airplane spraying of DDT:

During June a test of DDT in oil solution was made in an apple orchard by means of an airplane which was operating at Beltsville in connection with the spraying of woodlands. The spray solution consisted of DDT--1 pound, xylene 1 quart, and fuel oil No. 2 - 2.65 quarts. This formulation (DDT 12 percent by weight) was being carried by the plane for the woodland treatment and was used in the orchard merely as a convenience.

The spray was applied during quiet air conditions, row by row, at the rate of 5 gallons (5 pounds DDT) per acre. Cheesecloth-covered frames were distributed in different parts of the orchard for the purpose of studying the distribution of the spray by subsequent chemical analysis. Chemical analyses were also made of the DDT residue on samples of fruit and leaves.

Apples were articicially infested in the orchard by attaching codling moth eggs to leaves adjacent to the fruit. Untreated apples were similarly infested.

The results obtained were unsatisfactory in view of the fact that the fruit on the sprayed trees was as wormy as on the unsprayed. The spray solution injured both the fruit and foliage. Apparently the droplet size of the spray was much too large for satisfactory codling moth control and the spray was too unevenly distributed for effective results.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